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OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

OSWER Dir. No. 9355.4-01

MEMORANDUM

SUBJECT: Guidance on Remedial Actions for Superfund Sites With PCB Contamination
Superfund Management Review: Recommendation 23

FROM: Henry L. Longest II, Director
Office of Emergency and Remedial Response

Bruce M. Diamond, Director
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TO: Waste Management Division Directors
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Region II
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Purpose

The purpose of this memorandum is to transmit for your use the Guidance on Remedial Actions for Superfund Sites With PCB Contamination, the associated "Short Sheet", the joint guidance on Superfund's approach to the Toxic Substances Control Act (TSCA) anti-dilution provisions, and the guidance prepared by the Office of Toxic Substances on options for disposing of PCBs at Superfund sites.

Background

Approximately 12 to 17% of the sites on the National Priorities List involve PCB contamination. Because this represents a substantial number of Superfund sites and because PCB regulations are complicated, the Guidance on Remedial Actions for Superfund Sites With PCB Contamination was prepared to assist in streamlining efforts required to develop remedial alternatives for these sites.

An initial draft "working paper" was circulated for review in October 1988 and a workgroup meeting was held with Regional project managers and counsel in December 1988 in conjunction with the annual PCB seminar sponsored by the Office of Toxic Substances (OTS). Issues identified at this working session were discussed and resolved in meetings held in early 1989 between OERR and OTS. A draft version of the guidance was prepared and distributed for review in September 1989. Several comments were received and incorporated. A subsequent issue regarding the application of the anti-dilution provisions of TSCA to Superfund actions was identified and several meetings were held in early 1990 that resulted in agreement that these provisions apply to Superfund decisions prospectively (PCB wastes at Superfund sites cannot be further diluted in order to avoid the TSCA PCB disposal requirements) but do not require cleanup levels and technologies to be selected based on the form and concentration of the original PCB material spilled or disposed of at the site prior to EPA's involvement. This issue is discussed in a joint memorandum from the OSWER and the Office of Pesticides and Toxic Substances (OPTS) (attached). In conjunction with this joint memorandum the OTS developed Interim Guidance on Non-Liquid PCB Disposal Methods to Be Used as Alternatives to a 40 CFR 761.75 Chemical Waste Landfill (attached).

Following development of guidance on the anti-dilution issue, the attached Superfund guidance and "short sheet" were finalized.

Objectives

The objectives of this guidance are to promote a consistent approach to addressing PCB-contaminated Superfund sites by highlighting key considerations for effective, efficient remedial investigations and feasibility studies, outlining possible approaches for addressing PCB contamination, and describing the process for developing and evaluating response actions and selecting a remedy. This document describes the recommended approach for evaluating and remediating Superfund sites with PCB contamination consistent with the program expectations as defined in the NCP and the mandates of CERCLA as specified in the NCP.

This guidance fulfills part of Recommendation 23 of the Superfund program management review.

If you have questions on this guidance please contact your Regional Coordinator or Jennifer Haley at 475-6705. Printed copies of the guidance document will be available in 4 to 6 weeks and can be obtained by contacting the Publications Office in Cincinnatti at (513) 569-7562.

Attachments: Guidance on Remedial Actions for Superfund Sites With PCB Contamination

"Short Sheet" -- A Guide on Remedial Actions at Superfund Sites With PCB Contamination

Joint Memorandum: "PCB Contamination at Superfund Sites -- Relationship of TSCA Anti-Dilution Provision to Superfund Response Actions"

Interim Guidance on Non-Liquid PCB Disposal Methods to Be Used as Alternatives to a 40 CFR 761.75 Chemical Waste Landfill
[not available at time of mailing -- will be sent under separate cover]

cc: Superfund Branch Chiefs
Regions I - X

Superfund Section Chiefs
Regions I - X

[printed versions of the PCB Guidance and Fact Sheet will be distributed to Branch and Section Chiefs when they are available]

OSWER Directive No. 9355.4-01
August 1990

GUIDANCE ON REMEDIAL ACTIONS FOR SUPERFUND SITES WITH PCB CONTAMINATION

Office of Emergency and Remedial Response
U.S. Environmental Protection Agency
Washington, DC 20460

NOTICE

Development of this document was funded by the United States Environmental Protection Agency. It has been subjected to the Agency's review process and approved for publication as an EPA document.

The policies and procedures set out in this document are intended solely for the guidance of response personnel. They are not intended, nor can they be relied upon, to create any rights, substantive or procedural, enforceable by any party in litigation with the United States. EPA officials may decide to follow this guidance, or to act at variance with these policies and procedures based on an analysis of specific site circumstances, and to change them at any time without public notice.

Executive Summary

This document describes the recommended approach for evaluating and remediating Superfund sites with PCB contamination. It should be used as a guide in the investigation and remedy selection process for PCB-contaminated Superfund sites. This guidance provides preliminary remediation goals for various media that may be contaminated and identifies other considerations important to ensuring protection of human health and the environment. In addition, potential applicable or relevant and appropriate requirements (ARARs) and "to-be-considered" criteria pertinent to Superfund sites with PCB contamination and their integration into the RI/FS and remedy selection process are summarized. This guidance also describes how to develop remedial alternatives for PCB contaminated materials that are consistent with Superfund program expectations and ARARs. The guidance concludes with a discussion of considerations unique to PCBs that should be considered in the nine criteria evaluation and tradeoffs between options that are likely to occur.

Actions taken at Superfund sites must meet the mandates of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) as provided for in the National Contingency Plan (NCP). This requires that remedial actions protect human health and the environment, comply with or waive applicable or relevant and appropriate requirements, be cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, there is a preference for remedies that employ treatment that permanently and significantly reduces the mobility, toxicity, or volume of hazardous substances as a principal element. Although the basic Superfund approach to addressing PCB-contaminated sites is consistent with other laws and regulations, this consistency must be documented in the feasibility study and ROD to demonstrate that ARARs have been attained or waived. Primary Federal ARARs for PCBs derive from the Toxic Substances Control Act (TSCA) and the Resource Conservation and Recovery Act (RCRA).

To identify the areas for which a response action should be considered, starting point concentrations (preliminary cleanup goals) for each media are identified. These concentrations represent the level above which unrestricted exposure may result in risks exceeding protective levels. For soils, the preliminary remediation goals should generally be 1 ppm for sites in or expected to be in residential areas. Higher starting point values (10 to 25 ppm) are suggested for sites where non-residential land use is anticipated. Remediation goals for ground water that is potentially drinkable should be the proposed

MCL of .5 ppb. Cleanup levels associated with surface water should account for the potential use of the suface water as drinking water, impacts to aquatic life, and impacts through the food chain.

For contaminated material that is contained and managed in place over the long term, appropriate engineering and institutional controls should be used to ensure protection is maintained over time. An initial framework for determining appropriate long-term management measures is provided.

The Superfund program expectations should be considered in developing appropriate response options for the identified area over which some action must take place. In particular, the expectation that principal threats at the site should be treated, whenever practicable, and that consideration should be given to containment of low-threat material, forms the basis for assembling alternatives. Principal threats will generally include material contaminated at concentrations exceeding 100 ppm for sites in residential areas and concentrations exceeding 500 ppm for sites in industrial areas reflecting concentrations that are 1 to 2 orders of magnitude higher than the preliminary remediation goals. Where concentrations are below 100 ppm, treatment is less likely to be practicable unless the volume of contaminated material is relatively low.

The expectations support consideration of innovative treatment methods where they offer potential for comparable or superior treatment performance or implementability, fewer/lesser adverse impacts, or lower costs. This emphasizes the need to develop a range of treatment options. For PCBs, possible innovative technologies meeting these criteria include solvent extraction, potassium polyethylene glycol dechlorination (KPEG), biological treatment, and in-situ vitrification.

Protective, ARAR-compliant alternatives will be compared relative to the five balancing criteria: long-term effectiveness and permanence, reduction of toxicity, mobility, or volume through treatment, short-term effectiveness, implementability, and cost. Primary tradeoffs are most likely to occur under the long-term effectiveness and permanence, implementability, and cost criteria.

Final decisions should document the PCB concentrations above which material will be excavated, treatment processes that will be used, action levels that define the area that will be contained, long-term management controls that will be implemented, treatment levels to which the selected remedy will reduce PCB concentrations prior to disposal, and the time frame for implementation.

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Chapter 1

Introduction

This document describes the recommended approach for evaluating and remediating Superfund sites with PCB contamination. It provides starting point cleanup levels for various media that may become contaminated and identifies other considerations important to ensuring protection of human health and the environment that these cleanup levels may not address. In addition, potential applicable or relevant and appropriate requirements (ARARs) and "to-be-considered" criteria pertinent to Superfund sites with PCB contamination and their integration into the RI/FS and remedy selection process are summarized.

The guidance also describes how to develop remedial alternatives for PCB contaminated materials that are consistent with Superfund program expectations and ARARs. The guidance concludes with a discussion of considerations unique to PCBs that should be considered in the nine criteria evaluation and likely tradeoffs between options that are likely to occur.

1.1 Purpose

This guidance document outlines the RI/FS and selection of remedy process as it specifically applies to the development, evaluation, and selection of remedial actions that address PCB contamination at Superfund sites. The principal objectives of this guidance are to:

- o Present the statutory basis and analytical framework for formulating alternatives designed to address PCB contamination, explaining in particular the regulatory requirements and other criteria that can shape options for remediation;
- o Describe key considerations for developing remediation goals for each contaminated media under various scenarios;
- o Outline options for achieving the remediation goals and the associated ARARs;
- o Summarize the key information that generally should be considered in the detailed analysis of alternatives;
- o Discuss key tradeoffs likely to occur in the remedy selection process;
- o Provide guidelines for documenting remedies for PCB sites in a Proposed Plan and Record of Decision.

Although technical aspects of the investigation, evaluation, and remediation are not discussed in detail, pertinent references and, in some cases, summary information, are provided.

This document is intended for use by EPA remedial project managers (RPMs), State and other Federal Agency site managers responsible for Superfund sites involving PCBs, contractors responsible for conducting the field work and alternatives evaluation at these sites, and others involved in the oversight or implementation of response actions at these sites.

Although each Superfund site may present a unique set of environmental conditions and potential human health problems, general guidelines can be established for sites involving PCBs as the predominant chemical. Utilizing these general principles, site managers can streamline the RI/FS and remedy selection process by conducting a more efficient and effective study. This can be accomplished by: 1) specifying ARARs and other factors that shape the primary options for remediating such sites, 2) identifying key information necessary to fully evaluate those options, and 3) focussing on the major tradeoffs likely to emerge in the comparative analysis upon which remedy selection is based. Consideration of the factors outlined in this document should lead to consistent alternatives development and evaluation at sites involving PCB contamination.

1.2 Background

Approximately 12 percent of the Superfund sites for which Records of Decision (RODs) have been signed (69 of 581 total RODs as of 9/89) address PCB contamination. Preliminary assessment/site inspection data from all sites on the National Priorities List indicates that approximately 17 percent of the sites for which RODs have not yet been signed also involve PCBs. The RI/FS/remedy selection process for PCB sites is complicated for a number of reasons. From a regulatory point of view, there is an unusually high number of potentially applicable or relevant and appropriate requirements (ARARs) and pertinent "to-be-considered" guidelines for actions involving PCB wastes. PCBs are difficult to address technically due to their persistence and high toxicity. Finally, a large number of process options are potentially effective for addressing PCBs and deserve consideration. The approach outlined in this document attempts to address all three aspects of PCB remediation.

1.3 Focus of This Document With Respect to the Remedial Process and Superfund Expectations

The Superfund remedial process begins with the identification of site problems during the preliminary assessment/site inspection, which is conducted before a site is listed on the National Priorities List. The process continues through site characterization, risk assessment, and treatability studies in the RI, the development, screening, and detailed analysis of remedial alternatives in the FS, and culminates in the selection, implementation, and operation of a remedial action. Figure 1-1 shows the steps comprising the Superfund RI/FS process. Arrows indicate key decisions specifically addressed in this document.

The various components of the remedial investigation are not specifically addressed in this document; however, initial reference material including tables outlining properties of PCBs, analytical methods available, and data collection needs/considerations for technologies used to address PCBs are provided. In addition, a general discussion of the assessment of PCB impact on ground water

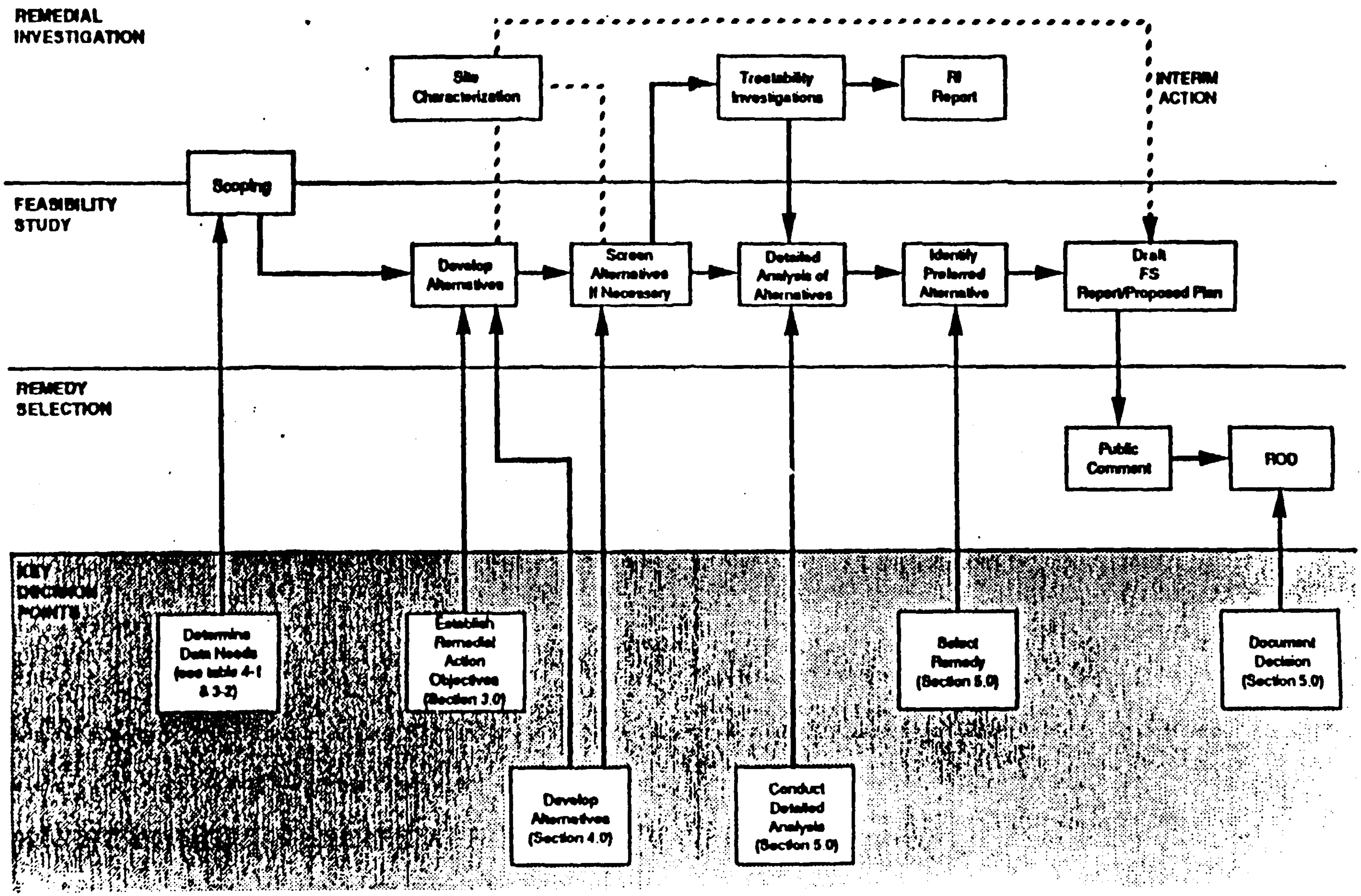

Figure 1-1 DECISION POINTS IN THE SUPERFUND PROCESS

and evironmental considerations which may be pertinent in the risk assessment is provided.

The focus of this guidance is primarily on the feasibility study: development and screening of alternatives, detailed analysis of alternatives, and the consequent selection of remedy. This process is designed to meet the overall Superfund goal to select remedial actions that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste. In addition to the overall goal, Superfund actions should consider the following program expectations:

- o Treatment of principal threats wherever practicable,
- o Containment of waste that poses a low long-term threat or where treatment is impracticable,
- o Institutional controls to mitigate short-term impacts or supplement engineering controls,
- o Remedies that combine treatment of principal threats with containment and institutional controls for treatment residuals and untreated waste,
- o Consideration of innovative technologies,
- o Returning contaminated ground water to its beneficial uses within a time frame that is reasonable, where practicable.

The implications of these expectations for PCB contaminated sites is described in appropriate sections of this document.

The development of alternatives involves completing the following steps, considering the program expectations described above:

1. Identify remedial action response objectives including the preliminary remediation goals that define the appropriate concentration of PCBs that could remain at the site without management controls.

2. Identify general response actions such as excavation and treatment, containment, or in-situ treatment. Identify target areas for treatment and containment consistent with Superfund program expectations and consistent with ARARs and TBCs specific to PCB contamination.

3. Identify process options for various response actions. Treatment options for PCBs include incineration,

solvent extraction, KPEG, or other removal/destruction methods. Immobilization techniques may also be considered. Long-term management controls appropriate for the material remaining on site should be noted.

4. Evaluate/screen process options to determine which are technically feasible for the site.

5. Combine feasible process options to formulate alternative remedial actions for detailed analysis.

This document provides general guidance on two primary aspects of the development of alternatives process that are considered and revised throughout the completion of the steps listed above:

- o Determination of the appropriate concentration of PCBs that can remain at a site (remediation goal) under various site use assumptions. This is based on standard exposure and fate assumptions for direct contact. A qualitative consideration of potential migration to ground water and environmental impacts is included for site-specific assessment.

  This concentration will reflect the level that will achieve the program goal of protection and will be achieved through removal and treatment to this level or by restricting exposure to contamination remaining above this level.

- o Identification of options for addressing contaminated material and the implications, in terms of long-term management controls, associated with these options. Remedial actions will fall into three general categories: overall reduction of PCB concentrations at the site (through removal or treatment) such that the site can be used without restrictions, complete containment of the PCBs present at the site with appropriate long-term management controls and access restrictions, and a combination of these options in which high concentrations are reduced through removal or treatment but the levels remaining still warrant some management controls.

  The determination of what combination of treatment and containment is appropriate will be guided by the program expectations to treat the principal threats and contain and manage low-threat material. The determination of what constitutes a principal threat will be site-specific but will generally include material contaminated at concentrations of PCBs that exceed 100 ppm (residential areas) or 500 ppm (industrial areas).

The type of treatment selected will take into account the program expectation to consider innovative treatment. Treatment that is often comparable in performance to but less costly than incineration may be attained using solvent extraction or KPEG. In addition, the potential for adverse affects from incineration can be removed through use of one of these technologies, in-situ vitrification, and in some cases, solidification.

For both evaluations, pertinent ARARs and TBCs are identified.

Finally, this document will: 1) discuss some of the unique factors associated with response actions at PCB-contaminated sites that might be considered under the detailed analysis of alternatives using the evaluation criteria outlined in the proposed NCP, 2) indicate how these factors might be evaluated in selecting the site remedy, and 3) outline the findings that should be documented for the selected remedy.

1.4 Organization of Document

The remainder of this document is divided into four chapters and six appendices, summarized below. At the beginning of each chapter a brief summary highlighting the main points of the section is provided.

Chapter 2 describes the potential ARARs and TBCs most commonly identified for sites involving PCB contamination. This discussion has been separated from the background section because of the complexity of the regulatory framework.

Chapter 3 provides general guidelines for determining PCB concentrations appropriate to leave on site under various scenarios. The primary factors affecting this determination are the medium that is contaminated, the exposure assumptions for the site, and the extent and level of contamination that is to be addressed.

Chapter 4 outlines the remediation options for material which warrants active response. Options include treatment that destroys the PCBs and long-term management controls that prevent exposure to PCBs. The regulatory implications of each option are discussed.

Chapter 5 summarizes the primary considerations associated with determining the appropriate response action for a PCB contaminated Superfund site in terms of the nine evaluation criteria used in the detailed analysis. Key tradeoffs likey to occur among alternatives are noted.

Finally, the findings specific to actions addressing PCBs that should be documented in the Record of Decision are presented.

Appendix A provides a summary of the Superfund sites involving PCBs for which RODs have been signed, including type of response action chosen and clean-up levels specified.

Appendix B provides the detailed calculations supporting the direct contact risk evaluation presented in Chapter 3.

Appendix C provides the backup calculations and methodology for the example evaluation of long term management controls presented in Chapter 4.

Appendix D includes two case studies of Superfund site actions involving PCB contamination: Peppers Steel, FL where the remedy involved solidification and Wide Beach, NY where treatment using the KPEG process was selected.

Appendix E provides a list of the currently permitted PCB disposal companies and their addresses and phone numbers. It also includes a list of EPA's Regional PCB disposal contacts in the TSCA program and their phone numbers.

Appendix F provides examples of long-term management controls implemented at several PCB Superfund sites where varying concentrations of PCBs were left on site.

Chapter 2

Potential ARARs and "To-Be-Considered" Guidelines
Pertinent to PCB Contamination Sites

Actions taken at Superfund sites must meet the mandates of CERCLA as provided for in the NCP. This requires that remedial actions protect human health and the environment, comply with or waive applicable or relevant and appropriate requirements, be cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, there is a preference for remedies that employ treatment that permanently and significantly reduces the mobility, toxicity, or volume of hazardous substances as a principal element. Although the basic Superfund approach to addressing PCB-contaminated sites is consistent with other laws and regulations, this consistency must be documented in the feasability study and ROD to demonstrate that ARARs have been attained or waived. Primary Federal ARARs for PCBs derive from the Toxic Substances Control Act (TSCA) and the Resource Conservation and Recovery Act (RCRA).

TSCA requires that material contaminated with PCBs at concentrations of 50 ppm or greater be disposed of in an incinerator or by an alternate method that achieves a level of performance equivalent to incineration. Liquids at concentrations above 50 ppm but less than 500 ppm and soils contaminated above 50 ppm may also be disposed of in a chemical waste landfill.

RCRA requirements apply to PCBs when liquid waste that is hazardous under RCRA contains PCBs at concentrations greater than 50 ppm or non-liquid hazardous waste contains total HOCs at concentrations greater than 1000 ppm. The land disposal restrictions require that prior to placing this material on the land, it must be incinerated unless a treatability variance is obtained.

Other requirements that derive from the Clean Water Act (CWA) and Safe Drinking Water Act (SDWA) and their implementing regulations may apply or be relevant and appropriate when the site involves surface or ground water contamination.

2.1 National Contingency Plan (NCP) (U.S. EPA, 1990a)

The primary regulation that governs actions at PCB-contaminated Superfund sites is, of course, the National Contingency Plan (NCP), which defines the framework for addressing the requirements of CERCLA. The provisions of the NCP form the basis for the guidance provided in this document and will not be discussed in detail here but will be discussed in each section as they form the basic structure for the approach. The NCP implements the following CERCLA requirements:

- Protect human health and the environment (CERCLA Section 121(b))

- Comply with the applicable or relevant and appropriate requirements (ARARs) of Federal and State laws (CERCLA Section 121 (d)(2)(A)) or justify a waiver (CERCLA Section 121 (d)(4))

- Be cost-effective, taking into consideration short- and long-term costs (CERCLA Section 121(a))

- Utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable (CERCLA Section 121(b))

- Satisfy the preference for remedies that employ treatment that permanently and significantly reduces the mobility, toxicity, or volume of hazardous substances as a principal element or provide in the ROD an explanation of why treatment was not chosen. (CERCLA Section 121(b))

The nine evaluation criteria discussed in Section 5 are designed to elicit the appropriate information that will form the basis for demonstrating that these requirements have been satisfied. Because remedies must attain the ARARs of other Federal and State laws, some background and summary material on the ARARs that address PCB contamination is presented in this section.

ARARs for treating or managing PCB-contaminated material derive primarily from two sets of regulations: the Toxic Substances Control Act (TSCA) PCB regulations and the Resource Conservation and Recovery Act (RCRA) land disposal restrictions (LDRs). Where PCBs affect ground or surface water, the Safe Drinking Water Act (SDWA) and Clean Water Act (CWA) may provide potential ARARs for establishing remediation goals; i.e., Maximum Contaminant Levels (MCLs), Maximum Contaminant Level Goals (MCLGs), and Water Quality Criteria (WQC). In addition, the PCB Spill Policy, which is not an ARAR although it is published in the Code of Federal Regulations, should be considered when determining cleanup levels at a site. Other "to-be-considered" (TBC) information is provided by guidances developed by the Office of Toxic Substances to assist in implementing the PCB regulations of TSCA.

2.2 TSCA PCB Regulations

The TSCA PCB regulations of importance to Superfund actions are found in 40 CFR Section 761.60 - 761.79, Subpart D: Storage and Disposal. They specify treatment, storage, and disposal requirements for PCBs based on their form and concentration. The disposal options for PCB-contaminated material are summarized in Table 2-1 and discussed in the following sections. A final section describes the storage requirements.

TSCA requirements do not apply to PCBs at concentrations less than 50 ppm; however, PCBs cannot be diluted to escape TSCA requirements. Consequently, under TSCA PCBs that have been deposited in the environment after the effective date of the regulation, February 17, 1978, are treated, for the purposes of determining disposal requirements, as if they were at the concentration of the original material. For example, if PCB transformers leaked oil containing PCBs at greater than 500 ppm, the soil contaminated by the oil would have to excavated and disposed of as if all of the PCB-contaminated soil contained PCBs at greater than 500 ppm. This reflects an interpretation of the anti-dilution provisions in TSCA (40 CFR 761.1(b)) and was developed with the intent of eliminating the incentive responsible parties might have to dilute wastes in order to avoid regulation.

EPA has clarified that the TSCA anti-dilution provisions are only applicable to CERCLA response actions that occur once a remedial action is initiated (U.S. EPA, 1990a). In selecting response action strategies and cleanup levels under CERCLA, EPA should evaluate the form and concentration of the PCB contamination "as found" at the site, and dispose of it in accordance with the requirements of 40 CFR 761.60(a)(2) (5). Cleanup levels and technologies should not be selected based on the form and concentration of the original PCB material spilled or disposed of at the site prior to EPA's involvement (i.e., the anti-dilution provision of the PCB rules should not be applied). Because EPA comes to a site under the CERCLA after the pollution has already occurred, and is acting under statutory mandate to select a proper cleanup level, EPA is not subject to the anti-dilution provision at CERCLA sites when it selects a remedy. However, the Agency may not further dilute the PCB

Table 2-1
REMEDIATION OPTIONS FOR PCB WASTE UNDER TSCA

PCB waste category	40 CFR Section	PCB concentration (ppm)	Incinerator (§761.70)	Chemical waste landfill (§761.75)	High efficiency boiler (§761.60)	Alternative method (§761.60(e))	Method approved by region	Drain, dispose as solid waste	Decontamination
Liquid PCB	761.60	≥500	X			X			
Liquids with flash point > 60° C	761.75	50-500	X	X	X	X			
Liquids with flash point < 60° C	761.75	50-500	X		X	X			
Other liquids that are also hazardous wastes	268.42(a)(1)	50-500	X		X	X			
Other liquids that are also hazardous wastes	268.42(a)(1)	≥500	X			X			
Nonliquids (soil, rags, debris)	761.60(a)(4)	≥50	X	X		X			
Dredged materials and minicipal sewage sludge	761.60(a)(5)	≥50	X	X		X	X		
PCB transformers (drained and flushed)	761.60(b)(1)	NS[a]	X	X					
PCB capacitors[b]	761.60(b)(2)	≥500	X						
PCB capacitors	761.60(b)(4)	50-500	X	X					
PCB hydraulic machines	761.60(b)(3)	≥50						X[c,d]	
PCB contaminated electrical equipment (except capacitors)	761.60(b)(4)							X[e]	
Other PCB articles	761.60(b)(5)	≥500[f]	X	X[g]					
Other PCB articles	761.60(b)(5)	50-500						X[e]	
PCB containers	761.60(c)	≥500[f]	X	X[d]					X[h]
PCB containers	761.60(c)	<500						X[d]	X[h]
All other PCBs	761.60(a)	≥50	X			X			

[a] Not specified.

[b] Exemptions for some small capacitors.

[c] Must also be flushed if hydraulic fluid contains >1,000 ppm PCBs and flushing solvent disposed of in accordance with §761.60(a).

[d] Drained liquid must be disposed of in accordance with §761.60(a).

[e] Must be drained of all free-flowing liquid. The disposal of the drained electrical equipment and other PCB articles is not regulated by 40 CFR 761. All liquids must be disposed of in accordance with paragraph (a)(2) or (3) of §761.60 (in an incinerator (§761.70), chemical waste landfill (761.75), high efficiency boiler, or by an alternative method (§761.60(e))).

[f] Due to a typographical error, 40 CFR 761 (July 2, 1985, p. 183) erroneously states this value as 50 ppm; refer to Federal Register, 44, 31514-31568 (May 3,1979) (USEPA).

[g] Drained of any free-flowing liquid and liquid incinerated in a §761.70 incinerator.

[h] Decontaminated in compliance with §761.79.

waste in order to avoid the TSCA PCB disposal requirements as part of a CERLCA cleanup.

2.2.1 Liquid PCBs at Concentrations Greater Than 500 ppm

Remediation Options for PCB Waste Under TSCA/RCRA

Waste Cat.	40CFR Sec.	Incin. 761.70	High Eff. Boiler 761.60	Alt. Method 761.60(e)
Liquid PCB	761.60	X		X
Other Liq. also Haz.	268.42(a)(1)	X		X

Liquid PCBs at concentrations greater than 500 ppm must be disposed of in an incinerator which complies with 40 CFR 761.70 or by an alternative disposal method that achieves a level of performance equivalent to incineration as provided under 761.60(e). This has been interpreted to imply that treatment residuals must contain less than 2 ppm PCBs.

2.2.2 Liquid PCBs at Concentrations Between 50 ppm and 500 ppm

Remediation Options for PCB Waste Under TSCA/RCRA

Waste Cat.	40CFR Sec.	Incin. 761.70	High Eff. Boiler 761.60	Alt. Method 761.60(e)	Chem. Waste Landfl. 761.75
Liq. w/ flash pt > 60C	761.75	X	X	X	X
Liq. w/ flash pt < 60C	761.75	X	X	X	
Other liq. also haz.	268.42(a)(a)	X	X	X	

Liquid PCBs at concentrations between 50 ppm and 500 ppm, can be disposed of in an incinerator or high efficiency boiler as described above, or in a facility that provides an alternative method of destroying PCBs that achieves a level of performance equivalent to incineration (equivalent method) approved under 40 CFR 761.60(e) (i.e., demonstrate achievement of less than 2 ppm PCBs in the treatment residual).

Liquids at these concentrations with a flash point greater than 60 degrees Centigrade (not considered ignitable as defined in 761.75(b)(8)(iii)) other than mineral oil dielectric fluid, can also be disposed of in a chemical waste landfill which complies with 40 CFR 761.75. However, the following actions must be taken:

- o Bulk liquids must be pretreated and/or stabilized (e.g., chemically fixed, evaporated, mixed with dry inert absorbant) to reduce its liquid content or increase its solid content so that a non-flowing consistency is achieved;
- o Containers of liquid PCBs must be surrounded by an amount of inert sorbant material capable of absorbing all of the liquid contents of the container.

2.2.3 Non-Liquid PCBs at Concentrations Greater Than or Equal to 50 ppm

Remediation Options for PCB Waste Under TSCA/RCRA

Waste Cat.	40CFR Sec.	Incin. 761.70	Alt. Treatmt. 761.60(e)	Chem. Waste Landfl. 761.75	Method Apprvd. by RA 761.60(a)(5)
Non-liq. soil, rags, debris	761.60(a)(4)	X	X	X	
Dredged material, munic. sewage sludge	761.60(a)(5)	X	X	X	X

Soils and municipal sludges contaminated with PCBs at concentrations greater than or equal to 50 ppm can be disposed of in an incinerator, treated by an equivalent method, or disposed of in a chemical waste landfill. Industrial sludges with PCB concentrations greater than 500 ppm may not be landfilled. The determination of whether contaminated material should be considered a soil or an industrial sludge should be made site specifically consistent with the current process for classifying material subject to the land disposal restrictions as either a pure waste or a soil and debris contaminated with a waste.

Dredged materials and municipal sewage treatment sludges that contain PCBs at concentrations greater than or equal to 50 ppm can also be disposed of by methods other than those noted above that are approved by the Regional Administrator. It must be demonstrated that disposal in an incinerator or chemical waste landfill is not reasonable and appropriate, and that the alternate disposal method will provide adequate protection to health and the environment.

2.2.4 PCB Articles, Containers, Electrical Equipment

Remediation Options for PCB Waste Under TSCA/RCRA

Waste Cat.	40CFR Sec.	Incin. 761.70	Alt. Treatmt. 761.60(e)	Chem. Waste Landfl. 761.75	Drain Dispose as sol. waste	Decon.
PCB transformers	761.60(b)(1)	X	X	X		
PCB capacitors (>= 500 ppm)	761.60(b)(2)	X	X			
PCB capacitors (50 - 500 ppm)	761.60(b)(4)	X	X	X		
PCB hyd. machines	761.60(b)(3)				X	
PCB elec. equip.	761.60(b)(4)				X	
PCB articles (>=500 ppm)	761.60(b)(5)	X	X	X		
PCB articles (50 - 500 ppm)	761.60(b)(5)				X	
PCB containers (>=500 ppm)	761.60(c)	X	X	X		X
PCB containers (<500 ppm)	761.60(c)				X	X

PCB transformers and capacitors (by definition (40CFR 761.60) these contain 500 ppm PCB or greater as opposed to

PCB-contaminated electrical equipment which contains less than 500 ppm) must be disposed of in an incinerator, by an alternate method which can achieve a level of performance equal to incineration, or in a chemical waste landfill. However, special procedures must be followed for disposing of transformers in chemical waste landfills and a special showing indicating that incineration capacity does not exist, that incineration of the capacitors will interfere with the incineration of liquid PCBs, or other good cause, must be made for disposing capacitors in landfills. These are described in 40 CFR 761.60(b).

PCB-contaminated electrical equipment (this includes transformers and other equipment other than capacitors which contain PCBs between 50 ppm and 500 ppm) must be drained of all free flowing liquid. The liquid must be disposed of in an incinerator, by an equivalent method, or in a chemical waste landfill. The drained equipment is not covered under TSCA regulations. PCB-contaminated capacitors must be disposed of in an incinerator or a chemical waste landfill.

PCB articles and containers with PCB concentrations greater than 500 ppm must be incinerated or disposed of in a chemical waste landfill provided all free flowing liquid is drained and incinerated. PCB articles and containers with PCB concentrations between 50 ppm and 500 ppm must be disposed of by draining all free flowing liquid and appropriately disposing of the liquid. The drained articles and containers can be disposed of as municipal solid waste.

2.2.5 TSCA Chemical Waste Landfill Requirements

The requirements for chemical waste landfills are described in 40 CFR Section 761.75 and outlined in Table 2-2. As indicated, the regulations do not require caps because the regulations were designed for operating landfills. Where Superfund remedial actions will leave PCBs in place or where PCB-contaminated material is excavated, treated, and re-disposed at concentrations that still pose a threat, capping consistent with chemical waste landfill requirements is generally appropriate. (Long-term management controls for PCB-contaminated material generally will also parallel RCRA closures.) However, some of the requirements specified under TSCA may not always be appropriate for existing waste disposal sites like those addressed by Superfund. When this is the case, it may be appropriate to waive certain requirements, such as liners, under the TSCA waiver provisions, 761.75(c)(4). Requirements may be waived when it can be demonstrated that operation of the landfill will not present an unreasonable risk of injury to health or the environment. This

Table 2-2
TSCA CHEMICAL WASTE LANDFILL REQUIREMENTS
(40 CFR SECTION 761.75)

1. Located in thick, relatively impermeable formation such as large area clay pans, or:

   - On soil with high clay and silt content with the following parameters:
     - in-place soil thickness of four feet or compacted soil liner thickness of three feet
     - permeability equal to or less than 1×10^{-7}
     - percent soil passing No. 200 Sieve, greater than 30
     - liquid limit greater than 30
     - plasticity index greater than 15.

   - On a synthetic membrane liner (minimum thickness of 30 mils.) providing permeability equivalent to the soil described above including adequate soil underlining and soil cover to prevent excessive stress on or rupture of the liner.

2. A. Bottom of the landfill liner system or natural in-place soil barrier at least 50 feet from the historical high ground water table. Floodplains, shorelands, and ground water recharge areas shall be avoided and there shall be no hydraulic connection between the site and standing or flowing surface water.

   B. If the landfill is below the 100-year floodwater elevation, surface water diversion dikes should be constructed around the perimeter with a minimum height equal to two feet above the 100-year floodwater elevation.

   If the landfill is above the 100-year floodwater elevation, diversion structures capable of diverting all of the surface water runoff from 24-hour, 25-year storm.

3. Located in an area of low to moderate relief to minimize erosion and to help prevent landslides or slumping.

4. Sampling of designated surface watercourses monthly during disposal activities and once every six months after disposal is completed.

5. Ground water monitoring at a minimum of three points (equally spaced on a line through the center of the landfill), sampling frequency determined on a site specific basis (not specified in regulation) samples analyzed for PCBs, pH, specific conductance, and chlorinated organics.

6. Leachate Collection System:

   A. Gravity flow drainfield installed above the liner (recommended for use when semi-solid or leachable solid wastes are placed in a lined pit excavated into a relatively unsaturated homogeneous layer of low permeable soil) or

   B. Gravity flow drainfield installed above the liner and above a secondary liner (recommended for use when semi-liquid or leachable solid wastes are placed in a lined pit excavated into relatively permeable soil) or

   C. Network of porous ceramic cups connected by hoses/tubing to a vacuum pump installed along the sides and under the bottom of the waste disposal facility liner (recommended for relatively permeable unsaturated soil immediately adjacent to the bottom and/or sides of the disposal facility).

7. Installation of a six foot woven mesh fence, wall, or similar device to prevent unauthorized persons and animals.

Note: Waiver Provision (761.75 (c)(4))- One or more of the above requirements may be waived as long as operation of the landfill will not present an unreasonable risk of injury to health or the environment.

demonstration may require column studies verifying that PCB movement through the soil will not adversely affect ground water. These waivers are distinct from the six waivers from ARARs provided under CERCLA Section 121(d)(2), which may also be invoked under appropriate circumstances.

2.2.6 Storage Requirements

The requirements for storage of PCBs are described in 40 CFR Section 761.65. The regulations specify that PCBs at concentrations of 50 ppm or greater must be disposed of within one year after being placed in storage. The regulations also include structural requirements for facilities used for the storage of PCBs and requirements for containers used to store PCBs.

PCBs stored as part of a Superfund action should be placed in facilities that meet the following specifications:

- o Provide an adequate roof and walls to prevent rain water from reaching the stored PCBs,
- o Provide an adequate floor which has continuous curbing with a minimum six inch high curb,
- o Contain no drain valves, floor drains, expansion joints, sewer lines, or other openings that would permit liquids to flow from the curbed area,
- o Floors and curbing constructed of continuous smooth and impervious materials, to minimize penetration of PCBs; and
- o Not located at a site that is below the 100-year flood water elevation.

PCBs subject to TSCA should not be stored longer than one year. In some cases, PCB-contaminated material may be generated during the RI/FS that will require storage that may exceed the one-year limitation under TSCA. Where the final disposition of the waste will be specified in the ROD, the exceedence of the TSCA storage limitation may be justified using a CERCLA waiver. An interim remedy waiver under CERCLA could be invoked. Since the removal action is interim in nature and the remedy determined in the ROD will comply with ARARs for final disposition of the waste, a waiver of the ARAR is justified. A memorandum supporting the action should be prepared and placed in the administrative record to document the finding.

2.3 RCRA Regulations Addressing PCBs

Closure requirements described under RCRA are considered potentially applicable or relevant and appropriate at Superfund sites. A detailed discussion of these requirements is not presented in this document since they are not specific to PCBs. Instead, guidelines for long term management controls consistent with RCRA closure requirements that are warranted under various closure scenarios are provided in section 4.3. (Further discussion of the closure requirements under RCRA and their use at Superfund sites can be found in the CERCLA Compliance With Other Laws Manual (U.S. EPA, 1989b).)

PCBs are specifically addressed under RCRA in 40 CFR 268 which describes the prohibitions on land disposal of various hazardous wastes. Note that RCRA regulations only apply to waste that is considered hazardous under RCRA; i.e., listed in 40 CFR 261.3 or characteristic as described in 40 CFR 261.2. PCBs alone are not a RCRA hazardous waste; however, if the PCBs are mixed with a RCRA hazardous waste they may be subject to land disposal restrictions as summarized below.

PCBs are one of the constituents addressed by the land disposal restrictions under the California List Wastes. This subsection of wastes covers liquid hazardous wastes containing PCBs at concentrations greater than or equal to 50 ppm and non-liquid hazardous wastes containing total concentrations of Halogenated Organic Compounds (HOCs) at concentrations greater than 1000 ppm. PCBs are included in the list of HOCs provided in the regulation (Appendix III part 268).

2.3.1 Liquid Hazardous Waste With PCBs at 50 ppm or Greater

As described in 40 CFR 268.42(a)(1), liquid hazardous (RCRA listed or characteristic) wastes containing PCBs at concentrations greater than or equal to 500 ppm must be incinerated in a facility meeting the requirements of 40 CFR 761.70. Liquid <u>hazardous</u> wastes containing PCBs at concentrations greater than or equal to 50 ppm but less than 500 ppm must be incinerated or burned in a high efficiency boiler meeting the requirements of 40 CFR 761.60.

A method of treatment equivalent to the required treatment may also be used under a treatability variance procedure if the alternate treatment can achieve a level of performance equivalent to that achieved by the specified method as described in 40 CFR 268.42(b).

2.3.2 Hazardous Waste With HOCs at 1000 ppm or Greater

Liquid and non-liquid hazardous wastes containing HOCs in total concentration greater than or equal to 1000 ppm must be incinerated in accordance with the requirement of 40 CFR 264 Subpart O.

Again, a method of treatment equivalent to the required treatment, under a treatability variance, may also be used.

Special considerations are pertinent for waste that falls into the category of soil and debris from a CERCLA remedial action or RCRA Corrective Action. The land disposal restrictions for CERCLA soil and debris went into effect November 8, 1988; however, no standards for disposal were published at that time. Consequently soil and debris contaminated with hazardous waste is banned from land disposal unless it meets existing standards for the pure waste or qualifies for a treatability variance. The preamble to the NCP, established a general presumption that a treatability variance is warranted for CERCLA soil and debris. Alternate treatment levels should be justified based on the treatability variance guidance levels (U.S. EPA, 1989h). For PCBs, residuals after treatment should contain .1 to 10 ppm PCBs for initial concentrations up to 100 ppm and above 100 ppm, treatment should achieve 90 to 99% reduction in concentration to qualify for a treatability variance.

Finally, hazardous wastes for which the treatment method is incineration or the treatment standard was based on incineration are subject to a 2-year capacity extension from the time that the standard went into place. Wastes that qualify for a capacity extension can be disposed without meeting the treatment requirements; however, they must be disposed of in a facility that is in compliance with the minimum technology requirements established for landfills in section 3004(o) of RCRA. The capacity extension for California List wastes when they are present in CERCLA soil and debris extends until November 8, 1990.

2.4 Clean Water Act

The Clean Water Act establishes requirements and discharge limits for actions that affect surface water. Water Quality Criteria (WQC) indicating concentrations of concern for surface water based on human exposure through drinking the water and ingesting fish as well as concentrations of concern to aquatic life have been developed for many compounds. For PCBs, the WQC for chronic exposure through drinking water and fish ingestion is .000079 ppb based on an excess cancer risk of 10^{-6}. This assumes consumption of 6.5 grams of estuarine fish and shellfish products and 2 liters of water per day over a 70 year lifetime. The level is the same if consumption of water is excluded indicating a relative negligible impact due to this source.

Acute toxicity to freshwater aquatic life is estimated to occur only at concentrations above 2 ppb. Acute toxicity to saltwater aquatic life is estimated to occur only at concentrations above 10 ppb. The water quality criteria for chronic effects are .014 ppb and .03 ppb for fresh and saltwater aquatic life, respectively.

These values are used as guides in the development of water quality standards for surface water that are enforced at the State level. States may account for other factors in establishing these standards including physical, chemical, biological, and economic factors. State standards and/or WQC are ARAR for surface water discharges. More detailed discussion of the CWA ARARs can be found in the CERCLA Compliance Manual (U.S. EPA, 1989b).

2.5 Safe Drinking Water Act

Under the Safe Drinking Water Act (SDWA), Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs) are established. MCLs for carcinogens are generally set at levels that reflect an excess cancer risk due to drinking 2 liters of water per day over a 70 year life of between 10^{-4} and 10^{-6}. They are set as close as practicable to the MCLG (which for carcinogens is zero) accounting for the use of the best available technology, cost, and analytical capabilities. MCLs must be attained by public water supplies. MCLGs are goals set at levels that would result in no known or anticipated adverse effects to human health over a lifetime. At Superfund sites, MCLs and non-zero MCLGs may be relevant and appropriate to contaminated ground water that is or could be used as drinking water.

An MCL of .5 ppb was proposed for PCBs in May 1989 (U.S. EPA, 1989d). The MCLG is zero because PCBs are possible carcinogens. As a proposed MCL, the .5 ppb level is a TBC that EPA recommends be considered in determining the appropriate cleanup level for potentially drinkable ground water. (The MCL for PCBs is expected to be finalized by September 1990.) More detailed discussion of the SDWA ARARs can be found in the CERCLA Compliance Manual (U.S. EPA, 1989b).

2.6 PCB Spill Cleanup Policy Under TSCA

The PCB Spill Cleanup Policy was published in 40 CFR 761.120 - 761.139 on April 2, 1987 and describes the level of cleanup required for PCB spills occurring after May 4, 1987 (the effective date). Because it is not a regulation and only applies to recent spills (reported within 24 hours of occurrence), the Spill Policy is not ARAR for Superfund response actions; however, as a codified policy representing substantial scientific and technical evaluation it has been considered in developing the guidance cleanup levels discussed in section 3. A summary of the policy follows.

2.6.1 Low Concentration, Low Volume Spills All Areas

For spills of low concentration PCBs (50 ppm to 500 ppm) involving less than one pound of PCBs, cleanup in accordance with procedural performance requirements is required. The requirements consist of double wash rinse and cleanup of indoor residential surfaces to 10 micrograms (ug) per 100 square centimeters (cm2) analyzed by a wipe test, and excavation of all soils within the spill area plus a 1-foot lateral boundary of soil and other ground media and backfilling with clean (less than 1 ppm PCB) soil. No confirmation sampling is required.

2.6.2 Non-Restricted Access Areas

For spills of 500 ppm or greater PCBs and spills of low-concentration PCBs of more than one pound PCBs by weight in non-restricted access areas, materials such as household furnishings and toys must be disposed of and soil and other similar materials must be cleaned up to 10 ppm PCBs, provided that the minimum depth of excavation is 10 inches. In addition, a cap of at least 10 inches of clean materials must be placed on top of the excavated area. Indoor and outdoor surfaces must be cleaned to 10 ug/100 cm^2, but low contact outdoor surfaces may be cleaned to 100 ug/100 cm^2 and encapsulated. Post clean-up sampling is required.

2.6,3 Industrial Areas

For spills of 500 ppm or greater PCBs and spills of low-concentration PCBs of more than one pound in industrial and other restricted access areas, cleanup of soil, sand, and gravel to 25 ppm PCBs is required. Indoor high contact and outdoor high contact surfaces must be cleaned to 10 ug/100

cm^2. Indoor low contact surfaces may be cleaned to 10 $ug/100\ cm^2$ or to 100 $ug/100\ cm^2$ and encapsulated. Outdoor low contact surfaces may be cleaned to 100 $ug/100\ cm^2$. Post cleanup sampling is required.

2.6.4 Outdoor Electrical Substations

For spills of 500 ppm or greater PCBs and spills of low-concentration PCBs of more than one pound at an outdoor electrical substation, cleanup of solid materials such as soils to 25 ppm or to 50 ppm (with a sign posted) is required. All surfaces must be cleaned to 100 $ug/100\ cm^2$. Post cleanup sampling is required.

2.6.5 Special Situations

For particular situations, decontamination to site-specific requirements established by EPA Regional Offices is required. These situations are:

1. Spills that result in direct contamination of surface waters;

2. Spills that result in direct contamination of sewers or sewage treatment systems;

3. Spills that result in direct contamination of any private or public drinking water sources;

4. Spills which migrate to and contaminate surface waters, sewers, or drinking water supplies;

5. Spills that contaminate animal grazing land; and

6. Spills that contaminate vegetable gardens.

2.7 Guidances

Several documents have been produced that provide background information and guidance on complying with the regulations and policy described above. Pertinent information provided by some of the more important documents are described in this section. This material is "to-be-considered" in developing remedies at Superfund sites.

2.7.1 Draft Guidelines for Permit Applications and Demonstrations -- Test Plans for PCB Disposal by Non-Thermal Alternate Methods (U.S. EPA, 1986c)

The most significant information in this document affecting actions taking place at Superfund sites is the discussion provided on evaluating the "equivalency" of technologies to incineration. As described in section 2.2, most PCB-contaminated material can be treated by an alternate method provided that it can achieve a level of performance equivalent to an incinerator or a high efficiency boiler. The guidance manual indicates that an equivalent level of performance for an alternate method of treatment of PCB-contaminated material is demonstrated if it reduces the level of PCBs to less than 2 ppm measured in the treated residual. The residual can then be disposed of on-site without further regulation. Otherwise, the material must be treated as if it were contaminated at the original level (i.e., disposed of in a chemical waste landfill or incinerated).

This level was based on the practical limit of quantification for PCBs in an organic matrix and consequently does not apply to aqueous or air emissions produced by the treatment process. For aqueous streams the guidance provides that they must contain less than 3 ppb PCBs. Releases to air must be less than 10 ug of PCBs per cubic meter. It should be noted that these levels apply to treatment processes only and were not intended to be used as cleanup standards for reentry or reuse.

2.7.2 Verification of PCB Spill Cleanup by Sampling and Analysis (U.S. EPA, 1985b)

This document describes methods for sampling and analyzing PCBs in various media. It also includes basic sampling strategies, identification of sampling locations, and guidance on interpreting sampling results. This manual may be useful in developing sampling plans at Superfund sites and in identifying appropriate methods for complicated sampling, for instance sampling of structures.

2.7.3 Field Manual for Grid Sampling of PCB Spill Sites to Verify Cleanup (U.S. EPA, 1986b)

This manual provides a step-by-step guidance for using hexagonal grid sampling primarily for determining if cleanup levels have been attained at the site. It discusses preparation of the sample design, collection, handling and preservation of the samples taken, maintenance of quality assurance and quality control, and documentation of sampling procedures used. It is a companion to the guidance described in section 2.7.2 that discusses in more detail the rationale and techniques selected. The field manual addresses field sampling only and does not provide information on laboratory procedures. This guidance may be useful in specifying the appropriate sampling after or during remedial action to assess progress toward achieving cleanup goals.

2.7.4 Development of Advisory Levels for PCB Cleanup (U.S. EPA 1986a)

This document provides the basis for the cleanup levels developed in the PCB Spill Policy. It discusses the assumptions made in addressing the dermal contact, inhalation, and ingestion pathways and may provide useful information for completing risk assessments at Superfund sites. An update to the calculations made in this document to account for recent policy on standard ingestion assumptions and revised cancer potency factor for PCBs has been provided in a memorandum (U.S. EPA, 1988d).

2.7.5 Risk Assessment Guidance for Superfund: Human Health Evaluation (RAG) (U.S. EPA, 1989e)

This document describes the human health evaluation process conducted as part of the risk assessment at Superfund sites. It includes standard assumptions for various exposure pathways that have been used to calculate starting point action levels in section 3 of this document.

A second volume, Environmental Evaluation Manual, addressing the environmental evaluation provides general guidelines on considerations pertinent to evaluating the impact of contamination on the environment.

Chapter 3

Cleanup Level Determination

This section describes various scenarios and considerations pertinent to determining the appropriate level of PCBs that can be left in each media that is contaminated to achieve protection of human health and the environment. For soils, the starting point action level (preliminary remediation goal) is 1 ppm for sites where unlimited exposure under residential land use is assumed. Higher starting point values (10 to 25 ppm) are suggested for sites where the exposure scenario is industrial. Remediation goals for ground water that is potentially drinkable should be the proposed MCL of .5 ppb. Cleanup levels associated with surface water should account for the potential use of the surface water as drinking water, impacts to aquatic life, and impacts through the food chain. Occasionally, stormwater runoff to nearby streams can contribute significant environmental or health risks, especially to those eating contaminated fish.

3.1 Soils

The concentration of PCBs in the soil above which some action should be considered (i.e., treatment or containment) will depend primarily on the exposure estimated in the baseline risk assessment based on current and potential future land use. This section has correspondingly been organized according to categories of alternatives differentiated by the expected direct contact that will occur. Other factors influencing the concentration to which soils should be excavated or contained include the impact the residual concentration will have on ground water and potential environmental impacts. Since these pathways are pertinent to all site categories, they are discussed in separate sections. The guideline concentrations provided in this section do not imply that action must be taken at a Superfund site, rather they indicate the area over which some action should be considered once it has been determined that action is necessary to provide protection of human health and the environment.

A summary of the guidelines discussed in this section is presented in Table 3-1.

TABLE 3-1
Recommended Soil Action Levels -- Analytical Starting Points
(Considers ingestion, inhalation, and dermal contact only)

Land Use	PCB Action Levels (ppm)
Residential	1 ppm
Industrial	10 - 25 ppm

These action levels and the assumptions discussed in the following sections can be used to reduce the need for detailed site-specific risk assessments; however, future site uses should be well understood and final cleanup levels must still reflect all relevant exposure pathways and be defensible on a site-specific basis.

The analysis of PCBs is complicated by the fact that there are 209 different PCB compounds[1] (Alford-Stevens, 1986). Common analytical methods are listed in Table 3-2.

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[1]Aracholors are groups of PCBs with different overall percentages of chlorine. For example, Arochlor 1242 contains 42% chlorine made up of tri- and tetra- chlorinated biphenyls. PCB isomers are those compounds that have the same number of chlorine atoms. Individual PCBs isomers, of which there are 209, are called congeners.

3.1.1 Preliminary Remediation Goals for Residential Areas

The concentration that defines the area over which some action must be taken is the concentration of PCBs that can protectively be left on site without management controls. In areas where land use is residential, this concentration will be based on standard assumptions for direct contact -- dermal, ingestion, and inhalation -- and should consider potential impact to ground water, which is discussed in section 3.1.4.

For Superfund sites, the risk remaining after remediation should generally fall within the range of 10^{-4} to 10^{-6} individual excess cancer risk. Based on the standard exposure assumptions associated with residential land use (ingestion, inhalation, and dermal contact), concentrations of .1 ppm PCBs to 10 ppm PCBs will generally fall within the protective range. A concentration of 1 ppm PCBs equates to approximately a 10^{-5} excess cancer risk assuming no soil cover or management controls. The 1 ppm starting point for residential scenarios reflects a protective, quantifiable concentration for soil. Lower concentrations (e.g., reflecting a 10^{-6} risk level) are not generally quantifiable and in many cases will be below background concentrations. (Because of the persistence and pervasiveness of PCBs, PCBs will be present in background samples at many sites.) A concentration of 1 ppm PCBs should therefore generally be the starting point for analysis at PCB-contaminated Superfund sites where land use is residential. Alternatives should reduce concentration to this level or limit exposure to concentrations above this level.

As part of the development of the cleanup levels in the PCB Spill Cleanup Policy, a detailed analysis of the direct contact pathways was performed by the EPA Office of Health and Environmental Assessment (U.S. EPA, 1986a). This analysis was subsequently updated to account for the revised cancer potency factor and ingestion assumptions (U.S. EPA, 1988d). This analysis estimates risk levels associated with various concentrations of PCBs based on physical parameters of PCB 1254. It is also estimated that a 10 inch cover of clean soil will reduce risks by approximately one order of magnitude. Using some of the basic assumptions associated with PCBs (e.g., mobility, volatility, absorption) described in this analysis and the standard exposure assumptions for residential land use presented in the Risk Assessment Guidance (U.S. EPA, 1989e), risk levels associated with various concentrations of PCBs in soil were calculated (see Appendix B). This analysis forms the basis for the

Table 3-2
ANALYTICAL METHODS FOR PCBs

Matrix	Method	GC	GC / MS	Detection Limit[1]	Quantification Limit[2]
Oil	Bellar and Lichtenberg	yes		less than 2 ppm	2 ppm
	ASTM 04059	yes		less than 2 ppm	2 ppm
Soil/ Sediment	Method 680		yes	~ 100 ppb	1 ppm
	Method 608[3,5]	yes		0.1 - 0.5 ppb	80 ppb
Water	EPA Method 505 (Microextraction)	yes		0.1 - 0.5 ppb (based on the arochlor present)	not given
	Method 508A[4] (Perchlorination)			0.1 - 0.5 ppb (as decachlorobiphenyl)	not given
	Method 680		yes	~ 100 ppb	1 ppm
	Method 608[3,5]	yes		0.1 - 0.5 ppb	0.5 ppb
Air	NIOSH Method 5503 Florosil sorbent, hexane extraction, GC/ECD	yes			

1 Detection limit indicates the concentration above which the presence of PCBs will be detected by the analytical method.

2 Quantification limit indicates the concentration above which the quantity of PCBs present can be determined.

3 U.S. EPA, 1986d.

4 U.S. EPA, 1988a, Glaser, 1981.

5 Method 608 depends on the presence of an intact Arochlor. Analysts can estimate possible PCB concentrations when intact Arochlors are not present. However, if this is done the presence of PCBs should be confirmed using Method 680. Method 680 can identify PCB isomers.

analytical starting point summarized here. The primary assumptions and an example calculation for a PCB concentration of 1 ppm are shown in Table 3-3. It should be noted that some of these assumptions may be overly conservative on a site-specific basis. For example, the calculation for the inhalation pathway assumes that someone is on the site 24 hours a day for 30 years and that the concentration of PCBs in the air in a house on this site will be the same as the concentration in the air outside. In many cases, partial covering of the soil will limit the level of PCBs that can volatilize. Another consideration is that the calculation was based on the properties of Arachlor 1254 and properties may vary for different congeners as shown in Table 3-4. Toxicities may also vary (McFarland, 1989; Kimbrough, 1987; Safe, 1985), though there is limited information on this and the toxicity based on Arachlors 1254 or 1260 should generally be used.

As noted above, these calculations reflect direct exposure assumptions only and may not be appropriate where ground water or ecological habitats are potentially threatened. These levels are consistent with the guidance provided by the PCB Spill Cleanup Policy which recommends a 10 ppm cleanup level with a 10 inch cover for residential areas.

3.1.2 Preliminary Remediation Goals for Industrial/Remote Areas

In remote areas or areas where land use is industrial, a more appropriate concentration at which to start analysis may be 10 to 25 ppm, since direct exposure is less frequent than for residential land use and higher concentrations will be protective. (Under the PCB Spill Policy this category includes sites that are more than .1 km from residential/commercial areas or where access is limited by either man-made or natural barriers (e.g., fences or cliffs).) For example, at Superfund sites located in industrial areas ingestion and inhalation exposures are more limited than for a residential area. Even assuming exposure equivalent to that in residential areas, these levels (10 to 25 ppm) are still within the acceptable risk range (approximately 10^{-4}) based on the direct contact exposure pathways, and in fact will reflect a lower risk due to the reduced frequency of exposure expected at the site. This is consistent with the PCB Spill Cleanup Policy which recommends a cleanup level of 25 to 50 ppm for sites in

Table 3-3
PCB DIRECT CONTACT ASSUMPTIONS
(See Appendix B for detailed calculation)

INGESTION:

Soil ingestion (1 to 6 years)	0.2 g/day[1]
Soil ingestion (7 to 24 years)	0.1 g/day[1]
Body weight child	16 kg[1]
Body weight adult	70 kg[1]
Absorption of PCBs from ingested soil	30%[2]

INHALATION

Adult inhalation rate	30 m^3/day[1]
Lung absorption of inhaled PCBs	50%

DERMAL

Surface area (3 - 18 years)	0.4 m^2/event[1]
Surface are (adult)	0.31 m^2/event[1]
Soil to skin adherence factor	2.77 mg/cm^2/1
Exposure frequency (child)	132 events/year[1]
Exposure frequency (adult)	52 events/year
Adsorption fraction	10%[3]

To estimate exposure, the average concentration of PCBs in soil over the exposure period is calculated. The concentration of PCBs will decrease with time due to volatilization.

EXAMPLE CALCULATION

At 1 ppm PCB initial soil concentration:
Average concentration over 10 inches over 6 years = 0.54 ppm
Average concentration over 10 inches over 30 years = 0.28 ppm

Risk due to soil ingestion = 2×10^{-6}
Risk due to inhalation = 7×10^{-6}
Risk due to dermal contact = 7×10^{-6}
Total risk (all pathways) = 1.6×10^{-5}

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[1]U.S. EPA, 1989e
[2]U.S. EPA, 1986a
[3]U.S. EPA, 1986a

Table 3-4
CHEMICAL AND PHYSICAL PROPERTIES OF PCBs

PCB	Molecular Weight	K_{ow}	Specific Gravity	Solubility[a] in Water (mg/l)	Vapor Pressure (mm Hg) at 25°C	Henry's Law Constant (atm-m³/gmol)
PCB-1016 (Arochlor 1016)	257.9	24,000		0.42	4×10^{-4}	
PCB-1221	200.7	12,000	1.182	15.0	6.7×10^{-4}	
PCB-1232	232.2	35,000	1.266	1.45	4.06×10^{-3}	
PCB-1242	266.5	380,000	1.380	0.24	4.06×10^{-4}	5.73×10^{-4} [b]
PCB-1248	299.5	1,300,000	1.445	5.4×10^{-2}	4.94×10^{-4}	3.51×10^{-3} [b]
PCB-1254	328.4	1,070,000	1.538	1.2×10^{-2}	7.71×10^{-5}	8.37×10^{-3} [c]
PCB-1260	377.5	14,000,000	1.620	2.7×10^{-3}	4.05×10^{-5}	7.13×10^{-3} [c]
PCB-1262			1.646			
PCB-1268			1.810			
PCB-1270			1.947			
PCB-2565			1.727			
PCB-4465			1.712			
PCB-5442			1.434			
PCB-5460			1.740			
2,2',5,5'-Tetra-chlorobiphenyl				4.6×10^{-2}		
2,2',3,4,5-Penta-chlorobiphenyl				2.2×10^{-2}		

[a] Hutzinger et al., 1974, Monsanto Chemical Co., undated.
[b] MacKay and Leinonen, 1975.
[c] Hwang, 1982, and U.S. EPA, 1980b.

Bioaccumulation factor: 31,200 L/kg, (U.S. EPA, 1986a)

Soil-water partition coefficient (U.S. EPA, 1980a): 22 - 1938 L/kg.

industrial or other reduced access areas.[2]

3.1.3 Assessing the Impact to Ground Water

Generally, PCB soil cleanup levels based on direct contact assumptions will provide sufficient protection of ground water. However, if ground water is very shallow, oily compounds are or were present, or the unsaturated zone has a very low organic carbon content, an additional evaluation of the residual concentration that will not exceed levels found to be protective for ground water should be made.

There are many factors such as soil permeability, organic carbon content, and the presence of organic colloids, which can influence PCB movement from soil into ground water. The situation is complicated by the low solubility of PCBs and the prevalence of their occurrence as solutes in oils. At this point the migration of PCBs to ground water can only be described qualitatively. Table 3-4 lists factors affecting migration for several PCBs.

PCBs are very immobile under conditions where the PCB concentration in the aqueous phase is controlled by the aqueous solubility of PCBs and transport is governed by partitioning between the water and soil. However, low solubility compounds like PCBs may migrate through facilitated transport on colloidal particles (Backhus, 1988) or dissolved in more mobile substances such as oils if present as a separate phase (U.S. EPA, 1989f). Measurements of dissolved organic carbon (DOC) in leachate may help assess this movement since PCBs will sorb to the organic material. Concentrations of PCBs in water samples exceeding PCB water solubility indicate that PCBs are being solubilized by something other than water. PCBs in oils will be mobile if the oil itself is present in volumes large enough to move a significant distance from the source. If immiscible fluid flow is significant, PCB transport predictions must be based on immiscible fluid flow models.

3.2 Ground Water

If PCBs have contaminated potentially drinkable ground water, ground water response actions should be considered.

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[2] The difference between the Spill Cleanup Policy numbers and the Superfund starting point concentrations is due to use of the Superfund standard exposure assumptions and a revised cancer potency factor for PCBs.

As discussed above, PCBs generally have low mobility but can be transported with oils in which they may be dissolved. A problem that arises is that once the immiscible fluid has been immobilized through capillary retention in the soil pore space (termed the residual saturation), PCB transport is governed by the rate at which the PCBs dissolve from the oil into the water moving past the residually saturated oil. This is a very slow process with the residual saturation serving as a long-term source of contamination. Emulsification of the residual oil, and PCB transport in micelles may also occur.

PCBs have also been found to migrate within aquifers sorbed to colloidal particles. This movement can be assessed through analyzing both filtered and unfiltered ground water samples for PCBs (U.S. EPA, 1989f and U.S. EPA, 1989g).

In both scenarios described above, PCBs can be found in unfiltered ground water samples at levels that exceed health based concentrations. The proposed MCL for PCBs is .5 ppb reflecting a 10^{-4} excess cancer risk. (Proposed MCLs are considered TBC for ground water that is potentially drinkable.) These situations are also very difficult to address actively. In the first case, residual oil lodged in pore spaces continues to be a source of PCBs and are very difficult to remove through traditional pump and treat methods. In the case of PCBs present on particulates, the rate of removal through ground water extraction may be very limited and substantial amounts of clean water will be affected as it is pulled into the contaminated zone. Because of the technical impracticability of reducing concentrations to health-based levels, remedies designed to prevent further migration of contaminants may be the only viable option for portions of the contaminated ground water. This may involve removing more soluble organics present which increase the mobility of the PCBs present.

3.3 Sediment

The cleanup level established for PCB-contaminated sediment may be based on direct contact threats using exposure assumptions specific to the site if the surface water is used for swimming. More often, the impact of PCBs on aquatic life and consumers of aquatic life will drive the cleanup level. Interim criteria for sediment based on achieving and maintaining WQC in the surface water have been developed for several chemicals (U.S. EPA, 1989a). The approach used to estimate these values is called the Equilibrium Partioning Approach (EP) which is based on two interrelated assumptions. First, that the interstitial water concentration of the contaminant is controlled by partitioning between the sediment and the water at contaminant concentrations well below saturation in both phases. Thus, the partitioning can be calculated from the quantity of the sorbent on the sediment and the appropriate sorption coefficient. For nonpolar organic contaminants, the primary sorbent is the organic carbon on the sediment; therefore, the partition coefficient is called the organic carbon normalized partition coefficient, K_{oc}. Second, the toxicity and the accumulation of the contaminant by benthic organisms is correlated to the interstitial, or pore water concentration and not directly to the total concentration of the contaminant on the sediment.

When the EP approach is used to estimate sediment quality criteria, chronic water quality criteria (WQC) (U.S. EPA 1980c and U.S. EPA 1985a) are used to establish the "no-effect" concentration in the interstitial water. The interstitial water concentration (C_w) is then used with the partition coefficients (K_{oc}) and the following equation:

$$C_{sed} = K_{oc} * C_w$$

to calculate the concentration of the contaminant on the sediment (C_{sed}) that at equilibrium will result in this interstitial water concentration. This concentration on the sediment will be the numerical criteria value (SQC).

Interim sediment quality criteria for PCBs are shown in Table 3-5. These values were derived using the Koc value of 6.14 for PCBs which was estimated using the median of the log mean Kow values for Arochlor 1242. Confidence limits (95%) around this Koc value based on preliminary uncertainty estimates range from 5.44 to 6.85. The WQC concentration of .014 ug/L for freshwater aquatic life (U.S. EPA, 1980b) is derived using the residue value of .64 ug/g from studies with mink and the mean bioconcentration factor for salmonids of 45,000. The WQC concentration of .03 ug/L PCBs for saltwater was not used. Instead, a WQC concentration of .024 ug/L for saltwater was calculated using the FDA Action level of 2.0 ug/g, a mean BCF of 10,400 and a lipid value for benthic species of 8.0 percent. Therefore, the SQC concentrations in Table 3-5 are intended to protect wildlife consumers of freshwater benthic species and the marketability of saltwater benthic species.

To determine if the sediment concentration of a nonpolar contaminant exceeds the sediment criteria values, the concentration of the contaminant and the organic carbon content of the sediment must both be known. Because the sediment criteria values are presented as normalized to organic carbon content (i.e., presented on a per organic carbon weight basis -- ug/gC), the normalized sediment concentrations of the contaminants must be calculated. These normalized concentrations can then be directly compared with the interim values shown in Table 3-5. SQC concentrations do not apply to sediments containing less than 0.5% organic carbon.

If concentrations of PCBs in sediments exceed these SQC values, chemical monitoring of indigenous benthic and water column species should be instituted to determine if prey species of wildlife or marketable benthic or water column species contain unacceptable concentrations of PCBs. Monitoring of indigenous wildlife species will provide insights into actual extent of exposure to PCBs from a specific site relative to reference sites. This is particularly important where the areal extent or the heterogeneity of sediment contamination by PCBs is great and because biomagnification of PCBs in food chains is not considered in deriving the aquatic life WQC concentrations. If chemical monitoring of biota fails to indicate that uses are impaired, the need for extensive remediation based on exceedence of SQC values should be questioned.

TABLE 3-5
PCB Sediment Quality Criteria[1]

	Sediment Quality Criteria (ug/gC)		Sediment Conc. (ug/g)	
WQC - Freshwater	Mean	95% Confid. Int.	OC = 10%	OC = 1%
.014 ug/L	19	3.8 - 99	1.9 (.38 - 9.9)	.19 (.038 -.99)
WQC - Saltwater				
.024 ug/L	33	6.6 - 170	3.3 (.66 -17)	.33 (.066 - 1.7)

[1] Based on Koc = 6.14 (5.44 - 6.85). If these SQC are exceeded chemical monitoring of PCB concentrations in indigenous biota is recommended prior to decisions on ecological risks or remediation. These SQC apply to sediments whose organic carbon (OC) concentrations are greater than .5%.

3.4 Ecological Considerations

The occurrence of PCBs at Superfund sites often poses significant threat to wildlife. Mobility of PCBs into ground water, into air, and through biological vectors can result in adverse ecological impacts beyond the immediate boundaries of the site. It is important to consider interactive ecological processes relative to PCB contamination as part of the remedial investigation. This evaluation can provide insights into other avenues of human exposure in addition to ensuring protection of wildlife.

Assessments of PCB sites by the Department of the Interior have concluded that PCB concentrations of 1 - 2 ppm will be protective of wildlife such as migratory birds and that providing a soil cover over more highly contaminated areas can further mitigate threats to acceptable levels. However, the uncertainty regarding environmental impacts described below may warrant more in-depth analysis at sites where this pathway may be of particular significance; e.g., sensitive species, high agricultural use.

It may be important to note that, from a toxicological and ecological perspective, not all PCB congeners will have the same effects. Discrimination of congeners appears operative at many physical, chemical, and biological levels: primary source materials differ from environmental samples; toxicity values differ among congeners; persistence in the environment varies; and bioaccumulation potential varies among congeners and across trophic levels. Consequently, an established environmental concentration based on total PCB concentration (i.e., irrespective of the specific congeners) may show little relationship to biological phenomena (e.g., food chain contamination, toxicity, etc.).

Metabolism of PCBs can occur in a diverse group of organisms including bacteria, plants, and animals. (Fungi almost certainly possess similar capabilities.) For the most part the lesser chlorinated congeners are more readily subject to metabolism, whereas the penta-, hexa-, and heptachlorinated forms are quite recalcitrant. Metabolism should not be equated with degradation, because certain conversions are better thought of as modifications of the parent compound; and in some cases the modified forms may become more toxic, more water-soluble, more bioavailable. To date the best evidence for degradation is demonstrated for certain bacteria which are capable of dechlorinating the lesser cholorinated congeners.

Toxicity symptoms are most clearly observed in animals (Focardi, 1989 and Aulerich, 1986). Usually the symptoms are sublethal. Chronic exposures lead to disrupted hormone balances, reproductive failure, teratomas, or carcinomas.

Plants do not appear to exhibit detectable toxicity responses to PCBs (Fletcher, 1987a and Fletcher, 1987b).

Biological contamination may occur through a variety of routes. Aquatic organisms may incorporate PCBs from water, sediment, or food items. Subterranean animals, similarly accumulate PCBs via dermal contact and ingestion (Tarradellas, 1982). Exposure scenarios in above-ground terrestrial populations additionally may occur via volatilization. The least understood features of food web contamination are those related to the uptake, fate and transport of PCB congeners in plants.

Chapter 4

Developing Remedial Alternatives

As described in Section 1, one of the Superfund expectations is that principal threats at a site will be treated wherever practicable and that low-threat material will be contained and managed. Treatment and disposal options for PCB contaminated material are governed by the type of material that is contaminated and the concentration of PCBs in the material that is to be disposed. Principal threats will generally include material contaminated at concentrations exceeding 100 ppm or 500 ppm depending on the land use setting. Where concentrations are below 100 ppm (less than 2 orders of magnitude above the starting point action level), treatment is less likely to be practicable unless the volume of contaminated material is relatively low.

The treatment options for contaminated soils and sludges mixed with soil are discussed in this chapter. (Consistent with the Superfund expectations and TSCA requirements, PCB liquids generally will be incinerated. Aqueous PCB streams generally will be treated by traditional treatment systems such as carbon adsorption.) There are three primary options for non-liquid PCBs at concentrations of 50 ppm or greater that are compliant with TSCA ARARs (there is no separate consideration given to non-liquid PCBs at concentrations greater than 500 ppm):

1. Incineration;
2. Treatment equivalent to incineration;
3. Disposal in a chemical waste landfill.

There are additional options for addressing PCB contaminated dredged material. Superfund expectations indicate that innovative treatment methods should be considered where they offer comparable or superior treatment performance, fewer/lesser adverse impacts, or lower costs than more demonstrated technologies. For PCBs, possible innovative technologies meeting these criteria include solvent extration, KPEG, biological treatment, and in-situ vitrification.

For low-threat material that is contained and managed in place over the long term, appropriate engineering and institutional controls should be used to ensure protection is maintained over time. An initial framework for determining appropriate long-term management controls is provided in Table 4-2. As indicated by this table, institutional controls alone are not sufficient to provide protection except in cases where the concentrations remaining are low and the expected land use is industrial.

4.1 Identifying Principal Threats/Low-Threat Areas

The process for developing alternatives at Superfund sites with PCB contamination described below is outlined in the flow chart in Figure 4-1.

Once the area over which some action must be taken to reduce risks has been identified; i.e., areas contaminated above 1 ppm PCBs (residential) or areas contaminated above 10 - 25 ppm PCBs (industrial), the wastes comprising the principal threat at the site should be identified. These wastes will include soil contaminated at 2 to 3 orders of magnitude above the action level. For sites in residential areas, principal threats will generally include soils contaminated at concentrations greater than 100 ppm PCBs. For sites in industrial areas, PCBs at concentrations of 500 ppm or greater will generally constitute a principal threat. This is consistent with TSCA regulations.[3] Consistent with Superfund expectations, the principal threats at the site should be treated. Treatment methods are described in Section 4.2.

In some cases, it may be appropriate to treat material contaminated at concentrations lower than what would otherwise define the principal threats because it is cost effective considering the cost of treatment verses the cost of containment, because the site is located in a sensitive area such as a wetland, or because the site is located in an area where containment is unreliable such as a floodplain. In other cases, it may be appropriate to contain the principal threats as well as the low-threat material because there are large volumes of contaminated material, because the PCBs are mixed with other contaminants that make treatment impracticable, or because the principal threats are not accessible; e.g., sites where they are buried.

Material that is not treated but is above actions levels should be contained to prevent access that would result in exposures exceeding protective levels. A framework of long-term management controls for various site scenarios is provided in section 4.3.

4.2 Treatment Methods

Several methods have been used or are currently being

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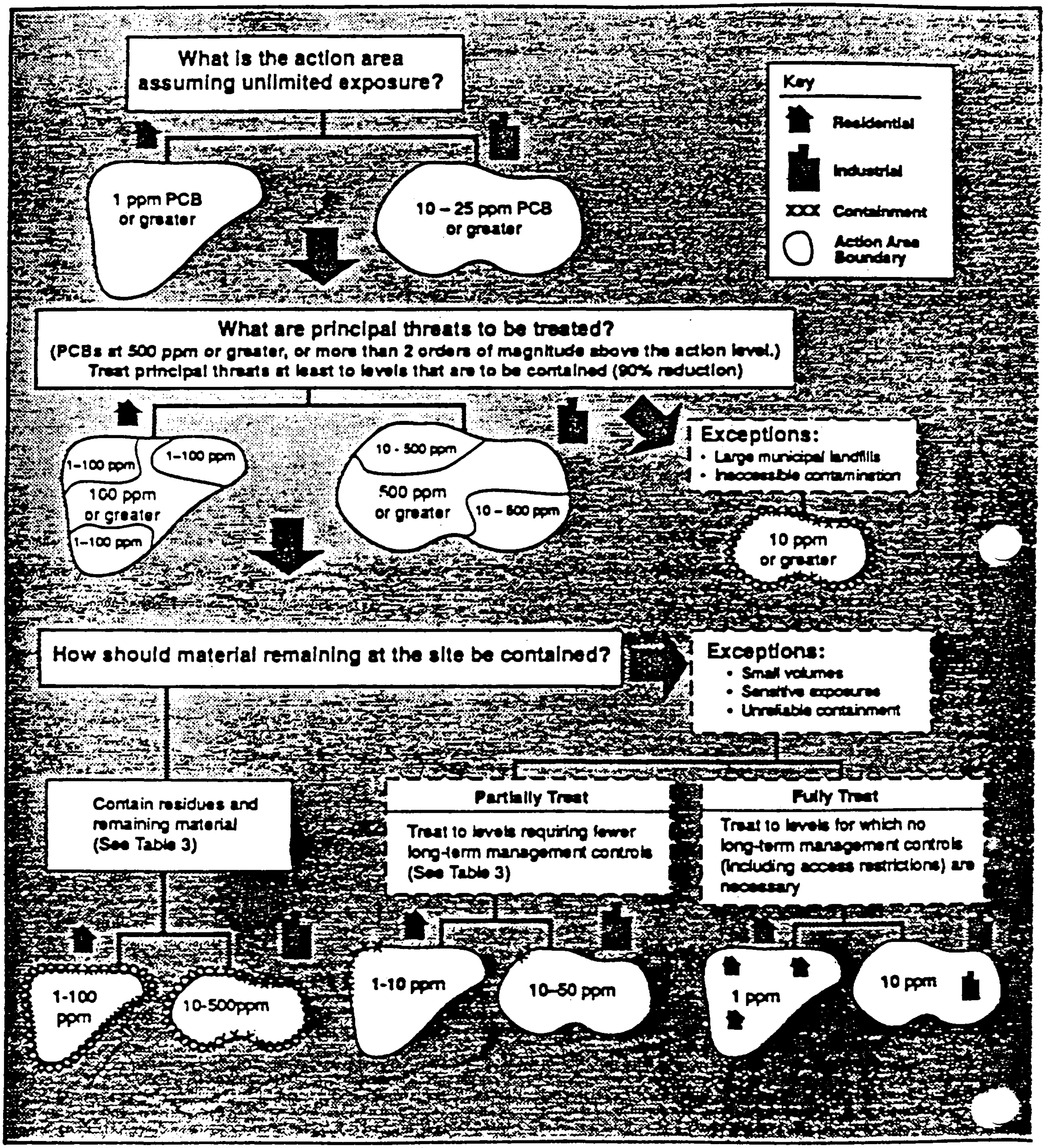
[3]TSCA regulations require that liquid PCBs at 500 ppm or greater be incinerated or treated by an equivalent method.

Figure 4-1 – Key Steps in the Development of Remedial Alternatives for PCB-Contaminated Superfund Sites*



* These numbers are guidance only and should not be treated as regulations.

evaluated to reduce the toxicity, mobility, or volume of PCB-contaminated material. Depending on the volume of material to be treated, the other contaminants that may be present, and the consistency of the contaminated material, one or more of these methods should be considered as options for addressing the principal threats.

In addition to incineration, there are several other technologies that result in the destruction or removal of PCBs in contaminated soil. These methods can be used with no long-term management of treatment residuals if they can be shown to achieve a level of performance equivalent to incineration, as required in 40CFR761.60(e). As described in guidance (U.S. EPA, 1986c), this determination can be made by demonstrating that the solid treatment residuals contain less than or equal to 2 ppm PCBs using a total waste analysis. When a remedial action alternative for a Superfund site involves use of a technology that can achieve substantial reductions but residual concentrations will still exceed 2 ppm, the alternative should include long-term management controls as outlined later in Table 4-2. This will not be considered equivalent treatment but will be treated as closure of an existing hazardous waste unit consistent with TSCA chemical waste landfill requirements (RCRA closure - 40CFR 264.301 and TSCA chemical waste landfill - 40CFR 761.75). As described in Table 4-2, certain long term management controls may be waived using the TSCA waiver provision, depending on the concentration of PCBs remaining and other site-specific factors.

A brief discussion of some of the pertinent considerations for several treatment technologies that address PCBs follows. The evaluations described below provide the substantive considerations pertinent to treatment of PCBs on Superfund sites. When material is transported off-site for treatment, the treatment facility must be permitted under TSCA. Table 4-1 summarizes important considerations and consequences associated with the use of the various technologies that should be accounted for in developing and evaluating alternative remedial actions.

4.2.1 Incineration

Incineration, covered in 40CFR761.70, should achieve the equivalent of six 9's (99.9999%) destruction removal efficiency. This is indicated by the requirement that mass air emissions from the incinerator stack shall not be greater than .001 g PCB/kg of PCB contaminated material fed into the incinerator.

Table 4-1
PCB TREATMENT METHODS AND APPLICATION CONSEQUENCES

Methods	Considerations/Consequences
Incineration	• Cost • Residual disposal (ash, scrubber water) • Public resistance
Biological Treatment	• Efficiency • By-products • Treatment time • Not proven effective for all PCB congeners
Solidification	• Volatilization • Leachability • Physical strength • Life of composite's integrity
Vitrification	• Cost • Volatilization • Leachability
KPEG (Potassium Polyethylene Glycolate)	• Cost (varies with reagent recycleability)* • Efficiency (varies with Arochlor type) • Aqueous wastes must be dewatered either as a pre-step or in a reactor
Solvent Washing/Extraction	• Volatilization of solvent • Solvent recovery • Inability of solvent to extract all PCBs • Several extraction steps • Solvent residual remains in extracted soil • Extracts require destruction via other methods
Granular Activated Carbon	• Removal efficiency in soil has not been established • Spent carbon requires treatment/disposal

4.2.2 Chemical Dechlorination (KPEG)

Chemical reagents prepared from polyethylene glycols and potassium hydroxide have been demonstrated to dechlorinate PCBs through a nucleophilic substitution process. Studies have shown that the products of the reaction are non-toxic, non-mutagenic, and non-bioaccumulative (desRosiers, 1987). Treatability studies in Guam and at the Wide Beach Superfund Site in New York have shown that PCB concentrations can be reduced to less than 2 ppm. However, variable concentrations in material to be treated will result in varying efficiencies of the treatment system and systems must be monitored carefully to ensure that sufficient reaction time is allowed.

This technology can achieve performance levels that are considered equivalent to incineration; however, treatability studies generally will be required to demonstrate that the concentration reductions can be achieved on a consistent basis for the material that is to be treated. In some cases, cost-effective use of the KPEG process will result in substantial reductions of PCB concentrations, but the residual levels may still be above 2 ppm, in which case chemical waste landfill requirements will also need to be met.

4.2.3 Biological Treatment

Some work has been done on the use of microbes to degrade PCBs either through enhancing conditions for existing microbes or mixing the contaminated material with engineered microbes (Quensen, 1988; Bedard, 1986; Unterman, 1988; Abramowicz, 1989). The use of this process requires detailed treatability studies to ensure that the specific PCB congeners present will be degraded and that the byproducts of the degradation process will not be toxic. For in-situ application, it is possible that extensive aeration and nutrient addition to the subsurface will increase the mobility of PCBs through transport on particulates. This phenomenon should be considered when potential ground water contamination is a concern.

In-situ application does not trigger TSCA requirements (unless disposal occurred after February 17, 1978) and the primary consideration should be attainment of cleanup levels established for the site based on the evaluation of factors described in Chapter 3. Biological processes involving the excavation of contaminated material for treatment in a bioreactor that can be shown to achieve residual concentrations of less than or equal to 2 ppm PCBs can be considered equivalent treatment. Treatment residuals can be re-deposited on site without long-term management controls as long as treatment byproducts do not present a threat to human health and the environment.

4.2.4 Solvent Washing/Extraction

Solvent washing/extraction involves removing PCBs from excavated contaminated soil and concentrating them in a residual side stream that will require subsequent treatment, generally incineration. Often the solvent can be recovered by taking advantage of certain properties of the solvent being used. Aliphatic amines (e.g., triethylamine [TEA]), used in the Basic Extractive Sludge Treatment (B.E.S.T.), exhibit inverse miscibility. Below 15 degrees C, TEA can simultaneously solvate oils and water. Above this temperature, water becomes immiscible and separates from the oil and solvent. Consequently, a process can be designed to remove water and organics at low temperatures, separate the water from the organic phase at higher temperatures, and recover most of the solvent through distillation. The high concentration PCB stream is then typically incinerated.

A similar process, called critical fluid extraction, involves taking advantage of increased solvent properties of certain gases (e.g., propane) when they are heated and compressed to their "critical point." Once the PCBs have been extracted, the pressure can be reduced allowing the solvent to vaporize. The solvent can be recovered and the remaining PCBs sent to an incinerator.

Treatability tests run to date have indicated that there is probably a limit to the percentage reduction (on the order of 99.5%) achievable with these processes. Repeat applications can increase the reductions obtained and studies have shown that PCB concentrations in the extracted soil of less than 2 ppm can be achieved. However, it may not be cost-effective for sites where there are large volumes of material at very high concentrations.

4.2.5 Solidification/Stabilization

The terms solidification and stabilization are sometimes used interchangeably, however, subtle differences should be recognized. Solidification implies hardening or encapsulation to prevent leaching, whereas stabilization implies a chemical reaction or bonding to prevent leaching. Solidification of PCBs can be accomplished by use of pozzolons such as cement or lime. Encapsulation, rather than bonding, occurs to prevent leaching of the PCBs. There is some evidence in the literature that the excess hydroxides are substituted on the biphenyl ring resulting in a dechlorination reaction (U.S. EPA, 1988c). The dechlorinated product would probably be less toxic than the parent molecule. Stabilization may be accomplished using a modified clay or other binder to bond to the PCB preventing leaching of the PCBs even under extreme environmental conditions. This product will probably be stable over time because of the binding, but no changes in the parent molecules are expected.

To assess the reduction in mobility achieved through solidification, leaching analysis, such as the Toxicity Characteristic Leaching Procedure (TCLP), should be performed before and after solidification. Since PCB migration potential is reduced but the PCBs are still present in the waste and the long term reliability of the treatment process is uncertain, long-term management controls as outlined in Table 4-2, based on the concentration of PCBs stabilized or up to a factor of 10 lower (based on the results of the performance evaluation), should be incorporated into the alternative.

4.2.6 Vitrification

Vitrification involves the use of high power electrical current (approximately 4 MW) transmitted into the soil by large electrodes which transform the treated material into a pyrolyzed mass. Organic contaminants are destroyed and/or volatilized, and inorganic contaminants are bound up in the glass-like mass that is created. Volatilized organics must be captured and treated. Since this process is often performed in-situ without disturbing the contaminated material, the requirements of TSCA would not be applicable unless disposal occurred after February 17, 1978. Also, it is often advantageous to consolidate contaminated material into one area for purposes of applying the process in which cases TSCA requirements would apply for PCBs at concentrations greater than 50 ppm since this movement constitutes disposal. Because the process results in complete pyrolosis of the PCBs in the affected area it is considered equivalent to incineration and no long-term management would be warranted based on the PCBs. The perimeter of the treated area should be tested using the TCLP to determine if long term management controls are warranted in areas where gradations in temperature resulted in lower levels of PCB destruction.

4.3 Determining Appropriate Management Controls for Areas Where Concentrations Are Above the Action Levels

Consistent with the Superfund expectations low-threat material should generally be contained on site. As described above, this will generally include soil with PCBs at concentration of less than 100 ppm (residential) or PCBs at concentrations of less than 500 ppm (industrial). The management controls that should be implemented for the material that remains at these sites above the action level will depend on the material that is to be contained and hydrogeological and meteorological factors associated with the site. Controls may include caps, liners, leachate collection systems, ground water monitoring, surface water controls, and site security. A general framework of appropriate controls under various site scenarios is provided in Table 4-2. If disposal of PCBs subject to TSCA (concentrations greater than 50 ppm) occurred after 1978, then the long-term management controls required for chemical waste landfills must be addressed for material that is not incinerated or treated by an equivalent method. As noted in the Table, where low concentrations of PCBs will remain on site and direct contact risks can be reduced sufficiently, minimal long term management controls are warranted. Controls should ensure that PCBs will not pose a threat to the ground water or any nearby surface water. TSCA waivers of particular chemical waste landfill requirements may be justified. Where TSCA landfill requirements are not applicable (post-78 disposal of >50 ppm PCB material did/does not occur), they will not be relevant and appropriate since RCRA closure requirements are generally the relevant ant appropriate requirement; consequently, the use of the TSCA waiver provision will not be necessary.

4.3.1 Example Analyses -- Long-Term Management Controls

To illustrate the process of determining the appropriate long-term management controls for low-threat PCB contamination that will remain at a site, an example was developed. A description of the models used in this evaluation is provided in Appendix C. The parameters used in this analysis are generally conservative. They are summarized in Table 4-3. Four different source area PCB concentrations were evaluated: 5 ppm, 20 ppm, 50 ppm, and 100 ppm.

The determination of the appropriate long term management controls for this example site was based on preventing access to concentrations of PCBs exceeding the action level (residential, 1 ppm; industrial 10 - 25 ppm) and preventing migration of PCBs to the ground water at concentrations that exceed the proposed drinking water standard -- .5 ppb. The migration to ground water pathway was assessed by

Table 4-2 – Selection of Long-Term Management Controls To Be Considered for PCB-Contaminated Sites

PCB - Concentration (ppm)	Approximate Depth to Ground Water	Access	RCRA Corollary	Long-Term Management Controls Reccomended: Cover System 1	Leachate Collection	Leak Detection	Bottom Liner	Ground Water Monitoring	Surface Water Monitoring	Surface Water Management	Chemical Waste Landfill Requirements: Bottom Liner	Depth to Ground Water	Ground Water Monitoring	Leachate Collection	Surface Water Monitoring	Fence	Potential Basis for TSCA Waiver (761.75 (c) (4)) of Indicated Chemical Waste Landfill Requirement(s)
≤ 1	All Depths	• Nonrestricted Access	Clean Closure														No waivers required; clean closure
1-10	All Depths	• Nonrestricted Access	Hybrid Closure	2							X	3	X	X	X	X	Low PCB concentration Design and Installation of a protective cover system Evaluation of PCB migration to GW and SW
10-25	All Depths	• Limited Access • Deed Notice	Hybrid Closure	2							X	3	X	X	X	X	Low PCB concentration Design and Installation of a protective cover system Evaluation of PCB migration to GW and SW
25-100	All Depths	• Restricted Access • Fence • Deed Notice	Landfill Closure	X				X		4	X	3		X	X		Relatively low PCB concentration Implementation of a GW monitoring program Evaluation of PCB migration to GW and SW Design and Installation of a protective cover system
100-500	3-30 Feet	• Restricted Access • Fence • Deed Notice	Landfill Closure	X				X	X	4	X	X		X			Implementation of GW monitoring program Design and Installation of a protective cover system Evaluation of PCB migration to GW and SW
	> 30 Feet	• Restricted Access • Fence • Deed Notice	Landfill Closure	X				5	X	4	X		X	X			Design and Installation of a protective cover system Demonstrate sufficient depth to GW to protect human health and the environment Evaluation of PCB migration to GW and SW
> 500	3-30 Feet	• Restricted Access • Fence • Deed Notice	Landfill Closure Minimum Technology	X	X	X	X	X	X	4		X					Demonstrate other long-term management controls will provide adequate protection of GW
	> 30 Feet	• Restricted Access • Fence • Deed Notice	Landfill Closure Minimum Technology	X	X	X	X	X	X	4	X			X			Demonstrate sufficient depth to GW and long-term management controls to protect human health and the environment Implementation of GW monitoring program Evaluation of PCB migration to GW and SW

GW = ground water; SW = surface water

1 Cover system may range from 12" soil cap for low concentrations to a full RCRA cap for concentrations exceeding 500 ppm.

2 The need for a cover system will depend on the land use (i.e., residential or industrial).

3 40 CFR 761.75(b)(3) requires that landfills be located at least 50 feet above the high-water table.

4 In accordance with 40 CFR 761.75(b)(4) if the site is located below the 100-year floodwater elevation, diversion dikes shall be constructed around the perimeter of the landfill site with a minimum height equal to 2 feet above the 100-year floodwater elevation. Flood protection for landfills above the 100-year floodwater elevation is not applicable to closed landfill units.

5 When the site is located in a permeable formation, incorporation of this long-term [illegible]

Table 4-3 SITE PARAMETERS
Source Area--5 Acres Average Regional Flow 310 ft/year Porosity of Soil--0.25 Bulk Density of Soil--1.97 g/ml Time--Peak 70 years from 0-10,000 years Contaminated zone organic content--5.0% Clean unsaturated zone organic content--0.5% Saturated zone organic content--0.1% PCB half-life--50 years Depth of Contamination--10 feet Depth to Groundwater--20 feet Thickness of Saturated Zone--5 feet

determining the infiltration projected through four different cap designs and then modeling the migration of PCBs from the source area to and into the ground water.

The four caps evaluated in this analysis are:

1. Twelve-inch soil cap
2. Twelve-inch soil cap with 24-inch clay layer
3. 24-inch soil cap, flexible membrane liner, and 12-inch cover soil, and
4. RCRA minimum technology cap including 24-inch soil cap, 12-inch sand drainage layer, flexible membrane liner, 24-inch clay layer, and 12-inch cover soil.

These caps are pictured in Figure 4-2. The infiltration expected through each of these caps, presented in Table 4-4, (given the site conditions presented in Table 4-3) was estimated using the Hydrologic Evaluation of Landfill Performance (HELP) model and the migration of PCBs to and into the ground water was estimated using a combination of a one-dimensional unsaturated zone finite-element flow and transport module called VADOFT (U.S. EPA, 1989f) and an analytical solute/heat transport module called AT123D (Yeh, 1981).

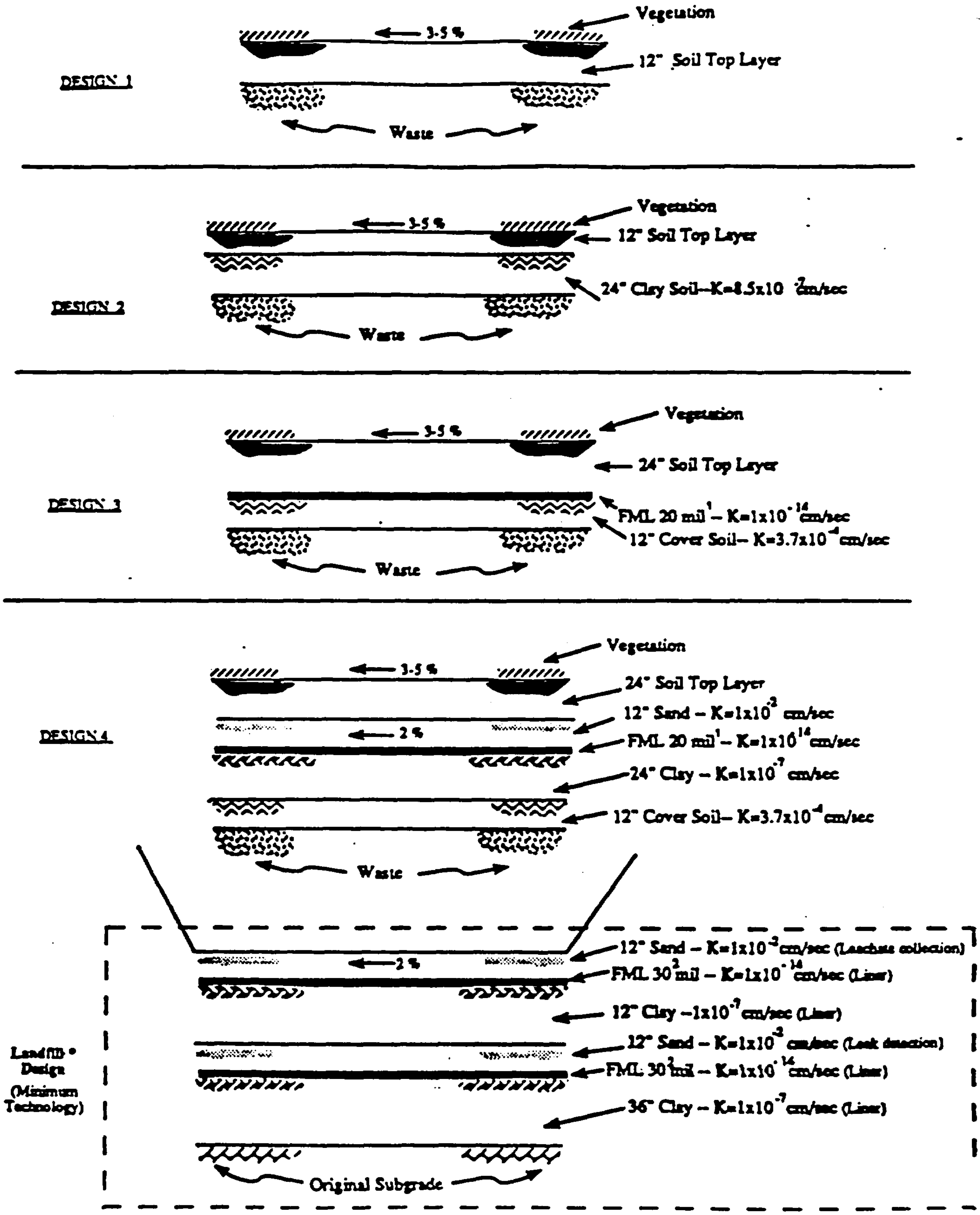
The results of this analysis are summarized in Table 4-5. PCB concentrations in ground water were estimated for each of the four cap designs and four different PCB source concentrations. Based on this analysis, the following recommendations for caps would be made:

5 ppm PCBs Source At this concentration the threat of PCB migration to ground water at concentrations that would exceed the proposed MCL of .5 ppb under the given site conditions is unlikely. The maximum concentration averaged over 70 years (occuring after 945 years) is .099 ppb with only a soil cap. The soil cover would be recommended for sites in residential areas to prevent contact with concentrations above 1 ppm, the starting point action level.

20 ppm PCBs Source Again, the analysis indicates that the threat to ground water is not significant. With only a soil cap, the maximum concentration expected is .4 ppb. For sites in residential areas, a cement cover and a deed notice may be warranted to prevent contact with PCBs exceeding the 1 ppm starting point action level.

50 ppm PCBs Source At 50 ppm, PCB concentrations in the ground water are projected to exceed the .5 ppb level slightly -- approximately 1 ppb. At this concentration, for the site conditions presented, cap design 2 (Figure 4-2)

Figure 4-2
Cap Design Details



* RCRA Minimum Technology Landfill bottom liner design for remedial actions requiring RCRA landfill construction.

Table 4-4
COVER DESIGN SUMMARY TABLE (ANNUAL VALUES)

Cover Design	Site Area (Acres)	Precip. (Cu.Ft.)	Runoff (Cu. Ft.)	Evapotrans. (Cu. Ft.)	Infiltration (Cu. Ft.)/ Acre
1	2	258,877	3,349	113,134	71,467
2	2	285,877	78,164	114,628	33,529
3	2	258,877	127,318	131,170	226
4	2	285,877	94,262	118,162	1

Table 4.3

SATURATED ZONE DEPTH AND TIME AVERAGED CONCENTRATIONS BENEATH THE SOURCE (PPB) AND TIME OF PEAK CONCENTRATION (YEARS)

Soil Concentration 5 ppm				Soil Concentration 20 ppm				Soil Concentration 50 ppm				Soil Concentration 100 ppm				T_{Peak} (Years)			
Cap Design 1	Cap Design 2	Cap Design 3	Cap Design 4	Cap Design 1	Cap Design 2	Cap Design 3	Cap Design 4	Cap Design 1	Cap Design 2	Cap Design 3	Cap Design 4	Cap Design 1	Cap Design 2	Cap Design 3	Cap Design 4	Cap Design 1	Cap Design 2	Cap Design 3	Cap Design 4
099	.029	0.0	0.0	396	.116	0.0	0.0	.990	.290	0.0	0.0	1.90	.580	0.0	0.0	945	1645	--	

would be recommended. The combination of a low-permeability cover soil and the soil cap will prevent PCBs from migrating to the ground water at levels that exceed .5 ppb. With the reduced infiltration the maximum PCB concentration projected for the ground water (occurring after 1645 years) is .3 ppb. Again, a deed notice would be warranted to prevent direct contact with the soil in the future.

<u>100 ppm PCBs Source</u> At 100 ppm, PCB concentrations in the ground water are projected to exceed the .5 ppb level slightly -- approximately .6 ppb, even with the addition of a low-permeability cover soil. At this concentration, for the site conditions presented, the cap design 3 (Figure 4-2) would be recommended. The addition of a flexible membrane liner reduces infiltration sufficiently to prevent migration of PCBs to the ground water. Consistent with Table 4-2, a deed notice, fence, and periodic ground water monitoring would also be recommended.

4.4 Dredged Material

A special allowance is made under TSCA for dredged material and municipal sewage treatment sludges in section 761.60(a)(5)(iii). If, based on technical, environmental, and economic considerations, it can be shown that disposal in an incinerator or chemical waste landfill is not reasonable or appropriate and that an alternative disposal method will provide adequate protection to health and the environment, this alternate disposal method will meet the substantive requirements of TSCA. Since these showings are integral components of any remedy selected at a Superfund site, Superfund actions involving PCB-contaminated dredged material generally will be consistent with TSCA.

4.5 RCRA Hazardous Waste

As noted in section 2.3.2, special consideration must be given to PCB-contaminated soil that also contains material considered hazardous under RCRA. Soil containing constituents that make it hazardous under RCRA that is excavated for the purpose of treatment or disposal must be treated consistent with the land disposal restrictions prior to placement and residuals managed in accordance with Subtitle C closure requirements. This means that a specific treatment method must be applied, or specified concentration levels must be attained for the waste contained in the soil, or a treatability variance must be obtained to establish alternate treatment standards. For soil and debris from CERCLA sites the need for a treatability variance is presumed (preamble to NCP, 55 Federal Register 8760-61, March 8, 1990). Treatment guidelines for constituents found in RCRA hazardous waste have been developed for use in treatability variances and should be used as a guide in determining the reductions in contaminant levels that should be attained by alternative treatment methods.

PCBs alone are not considered hazardous under RCRA since they are addressed under the TSCA regulations; however, land disposal restrictions do address PCBs under the California List Waste provisions for cases where PCBs are mixed with a waste that is considered hazardous under RCRA. If the waste is hazardous under RCRA, and the concentration of halogenated organic compounds exceeds 1000 ppm, the land disposal restrictions associated with California List Waste become applicable. A list of compounds regulated under the category of halogenated organic compounds is provided in 40 CFR part 268 Appendix III. PCBs are included on this list. Soil with HOCs exceeding 1000 ppm that is also considered hazardous under RCRA, must be incinerated or treated under a treatability variance. Under a treatability variance, treatment should achieve residual HOC concentrations consistent with the levels specified for a treatability variance for Superfund soil and debris. PCB concentrations must be reduced to .1 - 10 ppm for concentrations up to 100 ppm, and percent reductions of 90 - 99.9% must be achieved for higher concentrations (U.S. EPA, 1989h). If solidification is used, the levels specified under treatability variance guidelines apply to leachate obtained from application of the Toxicity Characteristic Leaching Procedure (TCLP).

The implications of the land disposal restrictions vary somewhat depending on whether the waste present is a listed hazardous waste or is hazardous by characteristic. If the soil contains a listed hazardous waste, once treatment consistent with the land disposal restrictions (i.e., specified treatment or concentration reductions consistent with the levels provided in the treatability variance guidelines for soil and debris) is employed, the residual after treatment must be disposed of in a landfill that meets the requirements of a RCRA Subtitle C Landfill. It may be possible to delist the residuals to demonstrate that it is no longer hazardous; this may be done for wastes on-site as part of the ROD; for wastes to be sent off-site, EPA Headquarters should be consulted regarding de-listing. If the concentration of PCBs remaining still exceeds 2 ppm, the landfill should also be consistent with a chemical waste landfill described under TSCA. As discussed in Section 4.3, fulfillment of RCRA Subtitle C Landfill Closure requirements will also guarantee fulfillment of TSCA chemical waste landfill requirements.

Table 4-6
EXAMPLE PCB COMPLIANCE SCENARIOS FOR CONTAMINATED SOIL

Waste Type and Concentration	Restriction(s) in Effect	Compliance Options to Meet Restrictions *
PCBs > 50 ppm	TSCA	• Dispose of in chemical waste landfill; • Incinerate; or • Use equivalent treatment to 2 ppm (solid residue) or 3 ppb (aqueous phase)
PCBs > 50 ppm, RCRA listed waste, and HOCs < 1,000ppm [in this case PCBs not covered by RCRA]	TSCA	• Must also be consistent with chemical waste landfill if final PCB concentration exceeds 2 ppm (solid residue)
	RCRA LDRs	• Treat to LDR treatment standard for listed waste; or • Obtain an equivalent treatment method petition; or • Obtain a treatability variance (soil and debris concentration levels as TBC); and • Dispose of according to Subtitle C restrictions
PCBs > 50 ppm, RCRA listed waste, and HOCs > 1,000 mg/kg	TSCA	• Dispose of in chemical waste landfill if final PCB concentration exceeds 2 ppm (solid residue)
	RCRA LDRs	• Treat to LDR PCB (i.e., incinerate) and listed waste treatment standard; or • Obtain an equivalent treatment method petition; or • Treat to treatability variance levels for Superfund soil and debris; and • Dispose of according to Subtitle C restrictions
PCBs > 50 ppm, RCRA characteristic metal waste, and HOCs < 1,000 mg/kg	TSCA	• Dispose of in chemical waste landfill if final PCB concentration exceeds 2 ppm (solid residue)
	RCRA LDRs	• Treat to BDAT or Treatability Variance levels and dispo according to Subtitle C restrictions • Solidify to remove characteristic (based on TCLP) and dispose according to Subtitle D restrictions
PCBs > 50 ppm, RCRA characteristic metal waste, and HOCs > 1,000 ppm	TSCA	• Dispose of in chemical waste landfill if PCB concentration exceeds 2 ppm (solid residue)
	RCRA LDRs	• Incinerate to LDR treatment standard for HOCs, solidify ash; or • Treat by equivalent method, solidify; or • Treat to treatability variance levels for PCBs in soil and debris • Treat residuals to meet BDAT/Treatability Variance and dispose according to Subtitle C or remove characteristic and dispose according to Subtitle D restrictions

If the soil contains material that makes it hazardous because of a characteristic; e.g., leachate concentrations exceed levels specified in 40 CFR 261.24, the soil should be treated to established BDAT levels, if any; if BDAT concentrations are not specified, the soil should be treated such that it no longer exhibits the characteristic. Once the BDAT level is achieved (if any) or the characteristic has been removed, it may be possible to land dispose the waste and Subtitle C landfill requirements would not be applicable but rather, the waste would be considered a solid waste and governed by Subtitle D. However, when PCBs are present in the waste, long term management controls consistent with the guidelines given in Section 4.2 should be employed.

4.6 Example Options Analysis -- Contaminated Soil

Table 4-6 outlines the ARARs that may have to be addressed for wastes with different constituents including those that will make the waste hazardous because either a listed waste is present or the material exhibits a hazardous characteristic. These restrictions apply only when PCB-contaminated waste is disposed. They do not require excavation of PCBs that were disposed prior to Superfund response.

Chapter 5

Analysis of Alternatives and Selection of Remedy

Consistent with program expectations, it will generally be appropriate to develop a range of alternatives for sites with PCB contamination, including alternatives that involve treatment of the principal threats using methods described in chapter 4 or more innovative methods in combination with long-term management of low-threat wastes consistent with the framework provided. As described in the Guidance on Conducting Remedial Investigations/ Feasibility Studies Under CERCLA, alternatives are initially screened on the basis of effectiveness, implementability, and cost (order of magnitude). Those alternatives that are retained are analyzed in detail against the nine evaluation criteria.

5.1 Evaluating Remedial Alternatives

The overall response options at any site range from cleaning up the site to levels that would allow it to be used without restrictions to closing the site with full containment of the wastes. Alternatives retained for detailed analysis are evaluated on the basis of the following criteria:

- o Overall protection of human health and the environment
- o Compliance with ARARs
- o Long-term effectiveness and permanence
- o Reduction of toxicity, mobility, or volume <u>through treatment</u>
- o Short-term effectiveness
- o Implementability
- o Cost
- o State acceptance
- o Community acceptance

The sections that follow will discuss in turn the first seven of these criteria and the special considerations that may be appropriate when PCB contamination is to be addressed. State and community acceptance are important criteria but are generally handled no differently for PCB sites than they are for other contaminated sites.

5.1.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment is achieved by eliminating, reducing, or controlling site risks posed through each pathway. As covered in section 3, this includes direct contact risks, potential migration to ground water, and potential risks to ecosystems. Often alternatives will involve a combination of methods (e.g., treatment and containment) to achieve protection. In general, remedies for PCB sites will involve reducing high concentrations of PCBs through treatment and long-term managment of materials remaining. The methods of protection used to control exposure through each pathway should be described under this criterion.

5.1.2 Compliance With ARARs

As outlined in section 2, the primary ARARs for alternatives addressing PCB contamination derive from the TSCA and the RCRA, and for actions involving PCB contaminated ground water and/or surface water, the SDWA and the CWA.

Since RCRA closure requirements are generally relevant and appropriate at Superfund sites even when a hazardous waste is not involved, a discussion of the measures taken at the site for the alternative being considered that are consistent with the RCRA requirements is warranted.

TSCA is applicable where disposal occurred after February 17, 1978 including any alternatives involving movement of material with 50 ppm or greater PCBs and compliance with the substantive requirements must be addressed. For alternatives that do not achieve the standards specified for treatment of PCBs under TSCA, consistency with long-term management controls associated with a chemical waste landfill must be demonstrated. Consistency may be achieved by complying with the specified landfill requirements or meeting the substantive findings to support a waiver as provided in the TSCA regulations (40 CFR 761.75).

Although the PCB Spill Policy is not ARAR, it is an important TBC. A statement indicating the relationship between the cleanup levels selected and the cleanup levels in the Spill Policy for alternatives involving no or minimal long term management controls is usually warranted.

Because PCBs adhere strongly to soil, it may be impracticable to reduce concentrations in the ground water to the proposed MCL level of .5 ppb throughout the entire plume, for sites where PCBs have migrated to the saturated zone. PCBs adsorbed to particulates can be removed in extraction wells; however, they will be drawn through the aquifer very slowly. A waiver from State standards or the MCL once it becomes final may be warranted for sites where ground water restoration time frames are estimated to be very long or where cleanup cannot be achieved throughout the entire area of attainment. Interim remedies (extraction for a specified period of time such as 5 years) to assess the practicability of extraction or other techniques may be worthwhile to determine the feasibility of achieving drinking water levels or at a minimum, reducing risks to the extent practicable.

5.1.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence addresses how well a remedy maintains protection of human health and the environment after remedial action objectives have been met. Alternatives that involve the removal or destruction of PCBs to the extent that no access restrictions are necessary for protection of human health and the environment provide the greatest long-term effectiveness and permanence. The uncertainty associated with achieving remediation goals for the treatment methods considered may distinguish alternatives with respect to this criterion. Alternatives that limit the mobility of PCBs through treatment such as solidification/stabilization afford less long-term effectiveness and permanence than alternatives that permanently destroy the PCBs, although solidification in combination with management controls can be very reliable based on the site-specific circumstances involved. Generally, alternatives relying solely on long-term management controls such as caps, liners, and leachate collection systems to provide protection have the lowest long-term effectiveness and permanence; however, this may be appropriate where low-concentration material is to be contained or where excavation is not practicable. Many alternatives will involve combinations of treatment and containment and will consequently fall at various points along the permanence continuum depending on the volume and concentration of residuals remaining on site.

5.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The anticipated performance of treatment technologies used in the alternatives is evaluated under this criterion. Alternatives that do not involve treatment achieve no reduction of toxicity, mobility, or volume through treatment and should not be described as doing so under this criterion (e.g., placing a cap over contaminated soil does not reduce mobility of PCBs through treatment). Alternatives that use treatment methods that have a high certainty of achieving substantial reductions (at least 90%) of PCBs have the greatest reduction of toxicity. Alternatives that treat the majority of the contaminated material through these processes achieve the greatest reduction in volume. Alternatives that utilize methods to encapsulate or chemically stabilize PCBs achieve reduction of mobility; however, most of these processes also increase the volume of contaminated material and this must be considered.

5.1.5 Short-Term Effectiveness

The effectiveness of alternatives in protecting human health and the environment during construction and implementation is assessed under short-term effectiveness. This criterion encompassess concerns about short-term impacts as well as the length of time required to implement the alternatives. Factors such as cross-media impacts, the need to transport contaminated material through populated areas, and potential disruption of ecosystems may be pertinent. Because PCBs do volatilize, remedies involving excavation will create short-term risks through the inhalation pathway. For actions involving large volumes of highly contaminated material this risk may be substantial; however, it can be controlled.

5.1.6 Implementability

The technical and administrative feasibility of alternatives as well as the availability of needed goods and services are evaluated to assess the alternative's implementability. Many of the treatment methods for PCBs require construction of the treatment system on-site since commercial systems for such techniques as KPEG and solvent washing may not be readily available. Other methods, such as bioremediation, require extensive study before their effectiveness can be fully assessed. This reduces the implementability of the alternative. Offsite treatment and disposal facilities must be permitted under TSCA and usually under RCRA as well if other contaminants are present. This may affect the implementability of alternatives that require PCB material be taken offsite due to treatment and disposal facility capacity problems and the need to transport contaminated material. Finally, the implementability of alternatives involving long-term management and limitations on site access to provide protection may be limited by the site location; e.g., flood plain, residential area.

5.1.7 Cost

Capital and operation and maintenance costs are evaluated for each alternative. These costs include design and construction costs, remedial action operating costs, other capital and short-term costs, costs associated with maintenance, and costs of performance evaluations, including monitoring. All costs are calculated on a present worth basis.

5.2 Selection of Remedy

The remedy selected for the site should provide the best balance of tradeoffs among alternatives with respect to the nine evaluation criteria. First, it should be confirmed that all alternatives provide adequate protection of human health and the environment and either attain or exceed all of their ARARs or provide grounds for invoking a CERCLA waiver of an ARAR. Some of the key tradeoffs for sites with

PCB contamination include:

- o Alternatives that offer a high degree of long-term effectiveness and permanence and reduction of toxicity, mobility, or volume through treatment, such as incineration, generally involve high costs. Short-term effectiveness for such alternatives may be low since risks may increase during implementation due to the need to excavate and possibly transport contaminated material, resulting in cross-media impacts.

- o Alternatives that utilize innovative methods, often less costly than incineration, to reduce toxicity, mobility, or volume are often more difficult to implement due to the need for treatability studies and to construct treatment facilities onsite. In addition, the treatment levels achievable and the long term effectiveness and permanence may be less certain.

- o Alternatives that involve stabilization to reduce the mobility of PCBs and limit cross-media impacts that may result from incineration (particularly important when other contaminants such as volatile metals are present) at a lower cost than other treatment methods, have higher uncertainty over the long term but may provide advantages in long-term effectiveness over alternatives that simply contain the waste in place.

- o Alternatives that simply contain PCBs do not utilize treatment to reduce toxicity, mobility, or volume of the waste, have lower long-term effectiveness and permanence than alternatives involving treatment, but are generally less costly, easy to implement, and pose minimal short-term impacts.

The relative trade-offs based on these considerations will vary depending on site specific considerations discussed in earlier sections; i.e., concentration and volume of PCBs, site location, and presence of other contaminants.

5.3 Documentation

Typically, a ROD for a PCB-contaminated site should include the following unique components in addition to the standard site characterization and FS summary information described in the Guidance on Preparing Superfund Decision Documents:

- o Remediation goals defined in the FS. For the selected remedy, the ROD should describe:

- Cleanup levels above which PCB-contaminated material will be excavated. A comparison of the levels selected to PCB Spill Policy levels and explanation of why they differ may be warranted.

- Treatment levels to which the selected remedy will reduce PCB concentrations prior to re-depositing residuals onsite or in a landfill. The consistency of these levels with the TSCA requirements (i.e., the requirement to demonstrate achievement of 2 ppm or less in solid treatment residue for material that will remain on site with no controls), and RCRA LDR requirements for hazardous wastes, should be noted.

o A description of technical aspects of the remedy, such as the following (should be included in alternative descriptions):

- Treatment process, including the disposition of all effluent streams and residuals.

- Time frame for completing the remedy and controls that will be implemented during this time to ensure protection of human health and the environment.

- Long term management actions or site controls that will be implemented to contain or limit access to PCBs remaining on site. The consistency with RCRA closure and TSCA chemical waste landfill measures, and necessary TSCA waivers, should be indicated.

Chapter 6

References

Alford-Stevens, Ann L., Analyzing PCBs, Environmental Science ar Technology, Vol 20, No. 12, 1986.

Aulerich et al, Assessment of Primary and Secondary Toxicity of Arochlor 1254 to Mink, Arch. Environmental Contaminant Toxicology 15: 393-399, 1986.

Backhus, Debera A. and Gschwend, Philip M., Fluorescent Polycycl Aromatic Hydrocarbons as Probes for Studying the Impacts of Colloids on Pollutant Transport in Ground Water, R.M. Parsc Laboratory for Water Resources and Hydrodynamics, Departmer of Civil Engineering, Massachusettes Institute of Technolog August 8, 1988.

Bedard, Donna L; Unterman, Ronald; Bopp, Lawrence H.; Brennan, Michael J; Haberl, Marie L.; Johnson, Carl, Rabid Assay for Screening and Characterizing Microorganisms for the Ability to Degrade Polychlorinated Biphenyls, Applied and Environmental Microbiology, pp 761-768, April 1986.

Brown, John F.; Wagner, Robert F.; Feng, Helen; Bedard, Donna L. Brennan, Michael J.; Carnahan, James C.; May, Ralph J., Environmental Dechlorination of PCBs, Environmental Toxicology and Chem., Vol. 6, pp 579-593, 1987.

des Rosiers, Paul E., Chemical Detoxification of Dioxin-Contaminated Wastes Using Potassium Polyethylene Glycolate, Dioxin '87, 7th International Symposium on Dioxins and Related Compounds, Las Vegas, NV, October 1987.

Fetter, C.W. Jr., Applied hydrogeology, Bell and Howard Co., pp 64, 1980.

Fletcher et al., Metabolism of 2-Chlorobiphenyl by Suspension Cultures of Paul's Scarlet Rose, Bulletin on Environmental Contaminant Toxicology 39:960-965, 1987a.

Fletcher et al., Polychlorobiphenyl (PCB) Metabolism by Plant Cells, Biotechnology Letters 9:817-820, 1987b.

Focardi et al, Variations in Polychlorinated Biphenyl Congener Composition in Eggs of Mediterranean Water Birds in Relatio to Their POsition in the Food Chain, Environmental Pollutio 52: 243-255, 1988.

Glaser et al., Trace Analyses for Water Waters, Environmental Science and Technology, Vol 15, pp 1426, 1981.

U.S. EPA, "PCB Contamination at Superfund Sites -- Relationship of TSCA Anti-Dilution Provisions to Superfund Response Actions," Memorandum from Don Clay and Linda Fisher, July 1990b.

U.S. EPA, Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A) (Interim Final), EPA/540/1-89/002, Office of Emergency and Remedial Response, December 1989f.

U.S. EPA, Risk of Unsaturated Transport and Transformation of Chemical Concentrations (RUSTIC), EPA/600/3-89/048a,b, July 1989g.

U.S. EPA, Stabilization of PCB Contaminated Soil, Memorandum from Edwin Barth to Jennifer Haley, September 26, 1988c.

U.S. EPA, Superfund Ground Water Issue -- Facilitated Transport, EPA/540/4-89/003, Office of Research and Development, August 1989h.

U.S. EPA, Superfund Ground Water Issue -- Ground Water Sampling for Metals Analysis, EPA/540/4-89/001, Office of Research and Development, March 1989i.

U.S. EPA, Superfund Land Disposal Restrictions Guide #6A -- Obtaining a Soil and Debris Treatability Variance for Remedial Actions, Office of Solid Waste and Emergency Response, Directive No. 9347.3-06FS, July 1989j.

U.S. EPA, "Update PCB Cleanup-Level Document," Memorandum from Michael Callahan to Henry Longest, December 6, 1988d.

U.S. EPA, Verification of PCB Spill Cleanup by Sampling and Analysis, EPA-560/5-85-026, Office of Toxic Substances, August 1985b.

U.S. EPA, Water Quality Criteria Document for PCBs, Federal Register 45 pp 79332, Office of Water, 1980c.

Unterman, Ronald; Brennan, Michael J., Brooks, Ronald E; Mondello, Frank J.; Mobley, David P; McDermott, John B.; Dietrich, David K; Wagner, Robert E., Bioremediation of PCBs in Soil; Research and Development Program for the Destruction pf PCBs, GE Research and Development Center, Schenectady, N.Y., June 1988.

Yeh, G.T., AT123D, Analytical Transient One-, Two-, and Three-Dimensional Simulation of Waste Water Transport in the Aquifer System, ORNL-5601, 1981.

APPENDIX A

SUMMARY REPORT

FY82 - FY89 RECORDS OF DECISION ADDRESSING PCB-CONTAMINATED MEDIA

SUMMARY REPORT OF FY82 THROUGH FY89
RECORDS OF DECISION THAT ADDRESS POLYCHLORINATED BIPHENYLS
AS A CONTAMINANT OF CONCERN

* SITE NAME, STATE [ROD SIGN DATE] [LEAD] COMPONENTS OF THE SELECTED REMEDY	COSTS	RD/RA COMPLETION DATES	AROCHLORS	PRE-TREATMENT CONCENTRATION	EXCAVATION LEVELS	ESTIMATED VOLUME	RATIONALE WHY INCINERATION WAS NOT SELECTED
REGION 01							
Cannon Engineering/Plymouth, MA [03/31/88] [F]							
Decontamination of all structures and debris with offsite disposal; excavation of contaminated soils with onsite thermal aeration; excavation of PCB contaminated soils and offsite incineration and disposal; restrict ground water use; ground water monitoring.	$2,700,000 Capital Cost	RD: (SCAP): 89/4 RA: (SCAP): 91/4	Not Stated	Not Stated	Not Stated	Not Stated	Incineration selected.
Norwood PCBs, MA [09/29/89] [F]							
Excavation and onsite treatment of PCB-contaminated soils and sediments using solvent extraction; area specific soil target cleanup levels established based on area risk assessment exposure scenarios; offsite incineration of oil extract from solvent extraction process; soil cover over treated soils; decontamination of machinery using solvents; extraction and treatment of PCB-contaminated ground water using carbon adsorption with offsite disposal of spent carbon; ground water use controls; and w[illegible]s restoration.	$16,100,000 Present Worth	RD: 91/3 RA: 92/4	1016 1254 1260	2,060 ppm sediment	1-25 ppm	31,550 cubic yards	Incineration was selected for oil extract from solvent extraction process. Incineration was chosen only as a contingency remedy for soil and sediment due to higher cost.

draft

TABLE 1
SUPERFUND GUIDELINES ON RESPONSE ACTIONS FOR PCB-CONTAMINATED SOIL

CLEAN-UP LEVELS:

PCB Concentrations in soil	Non-restricted Access[1]	Reduced Access[2]	Restricted Access[3]
1 - 10 ppm	Leave in place Cover w/ 10 inches clean soil (<1 ppm)	Leave in place	Leave in place
10 - 25 ppm	Excavate to 10 ppm and backfill with 10 inches clean (<1 ppm) soil	Leave in place	Leave in place
10 - 50 ppm	Excavate to 10 ppm and backfill with 10 inches clean (<1 ppm) soil	o Leave in place and cap o Excavate to 25 ppm[4]	o Leave in place, post warning signs o Excavate to 25 ppm[4]
50 - 500 ppm	Excavate to 10 ppm and backfill with 10 inches clean (<1 ppm) soil	o Establish as a TSCA/ RCRA (if hazardous waste also present) landfill o Excavate to 50 ppm[5] and cap o Excavate to 25 ppm[4]	o Establish as a TSCA/ RCRA (if hazardous waste also present) landfill o Excavate to 50 ppm[4] and post warning signs o Excavate to 25 ppm[4]
>500 ppm	Excavate to 10 ppm and backfill with 10 inches clean (<1 ppm) soil	o Excavate to 500 ppm and establish as a TSCA/RCRA landfill o Excavate to 50 ppm[5] and cap o Excavate to 25 ppm[4]	o Excavate to 500 ppm and establish as a TSCA/RCRA landfill o Excavate to 50 ppm[4] and post warining signs o Excavate to 25 ppm[4]

[1]Non restricted access areas (e.g., residential and commercial areas): Access to the contaminated area is essentially unlimited; in particular, children may gain easy access to the site and be able to ingest contaminated soil. This also includes unrestricted access rural areas (areas of low density development and popoultaion where access in uncontrolled by either man-made barriers or naturally occurring barriers, such as rough terrain, mountains, or cliffs).

[2]Reduced access areas (e.g., fenced industrial areas): The contaminated area must be at least 0.1 km from residential/commercial areas, and access must be limited by either man-made or natural barriers (e.g., fences or cliffs). These areas generally include industrial facilities and extremely remote rural locations. (Areas where access is restricted but are less than 0.1 km from a residential/commercial area are considered to be residential/commercial areas.)

[3]Restricted access areas (e.g., fenced electrical substations): Access to contaminated areas is completely restricted and has the equivalent characteristics of reduced access areas.

[4]Cleanup concentrations determined in the risk assessment for the site take precedence over the levels in this table if they indicate that protection of human health and the environment requires lower levels. The EPA OHEA Report: Development of Advisory levels for PCB Cleanup provides models that may be useful for evaluating risk levels. (The tables in this report are currently being revised to incorporate the latest data on soil ingestion rates and cancer potency factors for PCBs.)

[5]The determination of what concentration can remain at the site when the contaminated area will be capped is a site-specific one basedon a variety of factors such as depth to ground water and type of cap.